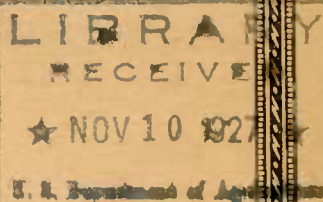


BEAVER HABITS AND EXPERIMENTS IN BEAVER CULTURE

BY

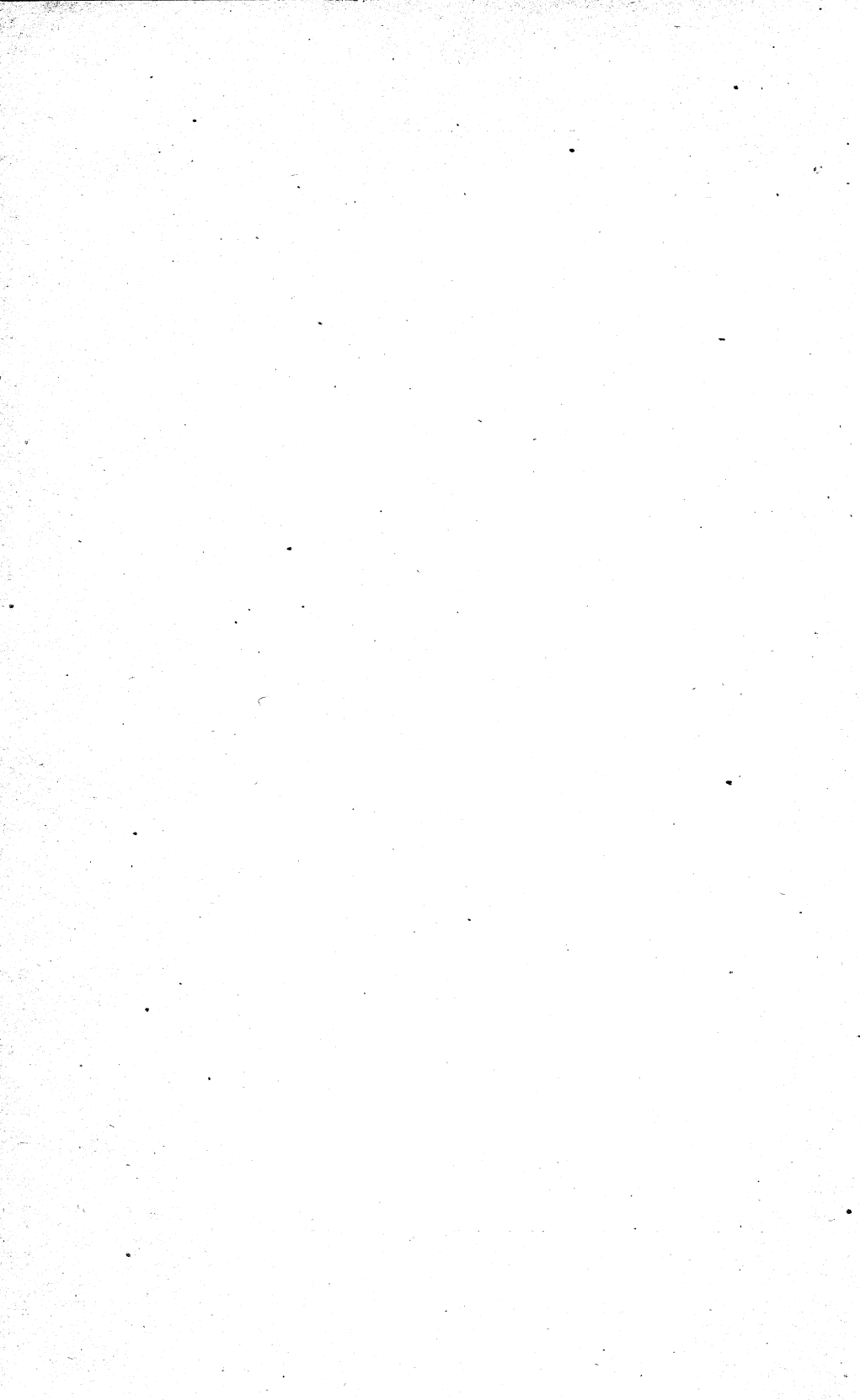
VERNON BAILEY

*Biologist, Division of Biological Investigations
Bureau of Biological Survey*



UNITED STATES DEPARTMENT OF AGRICULTURE

WASHINGTON, D. C.





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INTRODUCTION

Few of the native animals of North America have had a more important bearing on the history and development of the country than the beaver, and none has been so closely linked with the adventure and romance of the pioneer days. The fact that not one of our native mammals has become wholly domesticated points to the comparative newness of the country. Some of these animals might well be of great value to man if more fully under his control, and among them, the beaver, in a wholly controlled if not a fully domesticated condition, may eventually yield once more approximately the value it formerly yielded. Little change in the beavers will result, but a great change in man's attitude toward them and in his understanding of their natures, habits, and requirements will be necessary.

¹ This bulletin supersedes Department Bulletin No. 1078, *Beaver Habits, Beaver Control, and Possibilities in Beaver Farming.*

Originally beavers inhabited the greater part of North America and at one time produced fur of greater value than that of any other fur-bearing animal of the continent. They were to the native people an important source of food and warm clothing, and the beaver skin became a unit of barter with the Indians. Beaver fur soon attracted white traders and trappers, and traffic in the skins became an important commercial factor in promoting the early settlement of the country. Through the generations of intensive trapping that followed, beavers were greatly reduced in numbers and restricted in range until now they have been exterminated over much of their former area.

Beavers have been given protection in many sections of the country for a number of years and after being long absent have been restored to some parts of their old range, where under favorable conditions they have rapidly increased. In 1917, 20 States gave no protection to beavers. In 1927, 26 States had a close season, and 8 more gave partial protection. The advantages of such protection and subsequent increase, however, are sometimes defeated when the law again allows beavers to be almost exterminated for the benefit of a few trappers who are always eager to convert the beautiful skins of these animals into ready cash.

Since a great part of the original range of beavers is now under cultivation, and fields and orchards replace the primeval forests, it would be as unwise as it is impossible to restore the animals to all of their old homes. There are still many localities, however, where they could be introduced without harm and where, through storing water in the reservoirs along mountain streams, they would do much good by helping prevent floods and extensive erosion, by increasing the stream flow in dry weather, and by improving the fishing resources of streams and lakes. In such places they would not only enrich forests and parks with a unique and intensely interesting form of wild life, but also would add much to the decreasing supply of valuable fur.

On the other hand, there are many localities in the mountains and remote wildernesses where beavers, if allowed unrestricted freedom, would surely destroy much valuable timber, ruin many attractive lake and stream borders, destroy trails and roads, and even endanger railroad beds and human lives. Although interesting, desirable, and valuable animals in their place, they must be controlled to a certain extent if they are not to become troublesome and destructive.

Necessary control of beavers in any part of the country need not be difficult if based on a thorough knowledge of the animals and their habits. Controlling them under conditions of semidomestication as a business enterprise has not yet been fully tested, but with present knowledge of their habits there is every reason to believe that beaver culture will develop into a profitable industry.

At present a serious obstacle to successful beaver farming is that of legally obtaining breeding stock from parts of the country where the most valuable fur bearers are native. In the game laws of most of the States there are provisions for raising under license fur-bearing animals as a private industry, but in many States no provision is made for obtaining native species for starting fur farms. Naturally the need and demand must come before the law is created,

and it is to be hoped that State laws and regulations will be enacted to encourage an industry that promises so much for the future development of private and public welfare.

The first step in beaver farming is to find where satisfactory breeding stock can be procured. In most cases it has been necessary to start with such animals as can be readily obtained. With foxes and other fur-bearing animals the stock may usually be had from licensed dealers, and eventually this will be true with beavers. The next step is to procure a license, where required, for raising fur-bearing animals. This license can usually be obtained from the State game department or conservation commission at a nominal fee and will permit the holder to buy, sell, and possess protected fur bearers at any season of the year under certain necessary regulations.

GEOGRAPHIC DISTRIBUTION

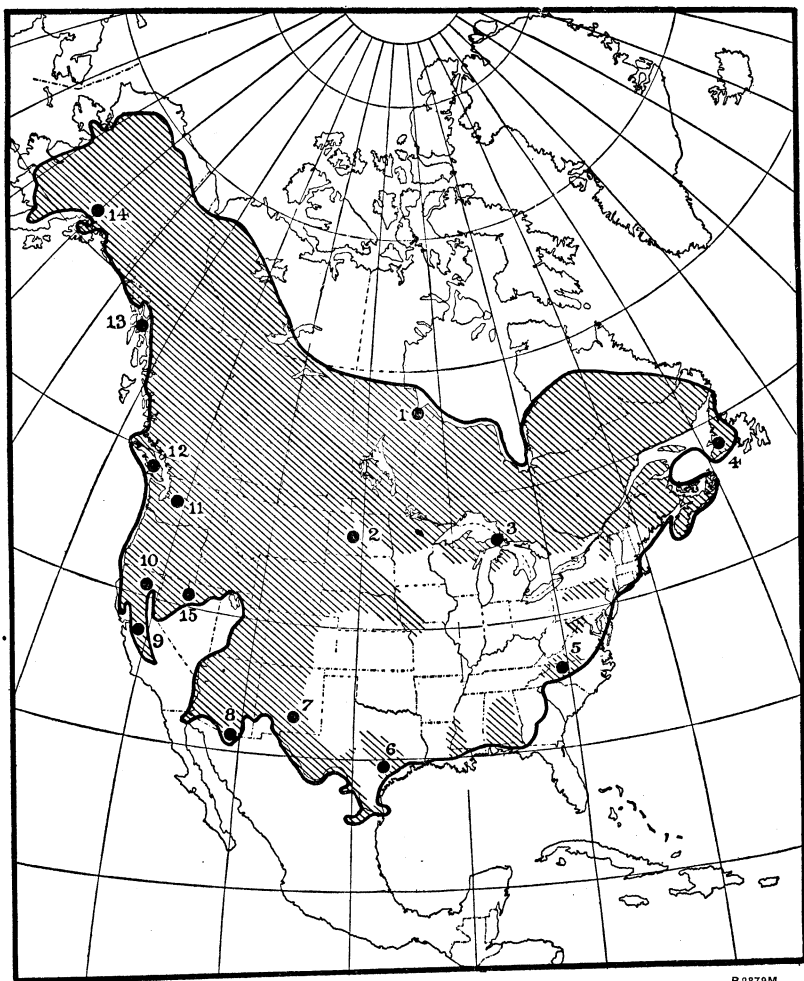
Beavers originally occupied the streams and lake shores of most of the continent of North America, from northern Florida and the lower Rio Grande and Colorado Rivers north to the forest limit in Labrador, Canada, and Alaska. (Fig. 1.)

Few native animals have shown such a wide distribution with so little variation in characters. Except for lighter and darker coloration, they have a close superficial resemblance throughout this great area, but critical examination shows recognizable structural as well as color differences conforming generally to the drainage systems inhabited or areas of similar climatic conditions. Fifteen species and subspecies, or geographic races, have been described from North America, as indicated by the type localities on the accompanying map. The palest and least valuable fur is found in the southwestern United States and the Rocky Mountain region. In the Columbia River drainage and northward through Canada and Alaska the fur is dark brown and valuable, but the darkest and most beautiful beaver fur known is found along the south shore of Lake Superior in northern Michigan and Wisconsin. Here the long winters, deep snows, and dense forest shade and possibly even the brown water of many of the streams of the region have contributed to produce the darkest and richest colors in beaver fur.

DESCRIPTION AND HABITS

Beavers are compact, heavy-bodied animals, with strong frames and powerful muscles. They have broadly flattened, naked tails, and dense coats of fine, soft, waterproof underfur, hidden by coarse outer guard hairs. (Pl. 1.) The underfur varies locally from buffy yellow to brownish black, and the coarse outer hairs vary from light brown to dark chestnut.

The hind feet are large, and the five long toes are fully webbed for swimming, the two inner toes on each foot being provided with remarkable double combing claws. (Pl. 2, A.) The front feet are small and unwebbed and are used mainly as hands for holding food or carrying and handling building material, or as feet in walking. The eyes are small, and the vision evidently is not very keen except under water. The ears are short, fur lined, and valvular, closing as the animals dive and opening instantly as they come to the sur-



B 2879M

Fig. 1.—Distribution of beavers in North America. Original range inclosed by heavy black line, and approximate present range indicated by the shaded area within. Type localities of described forms shown as black spots, numbered from 1 to 15, as follows:

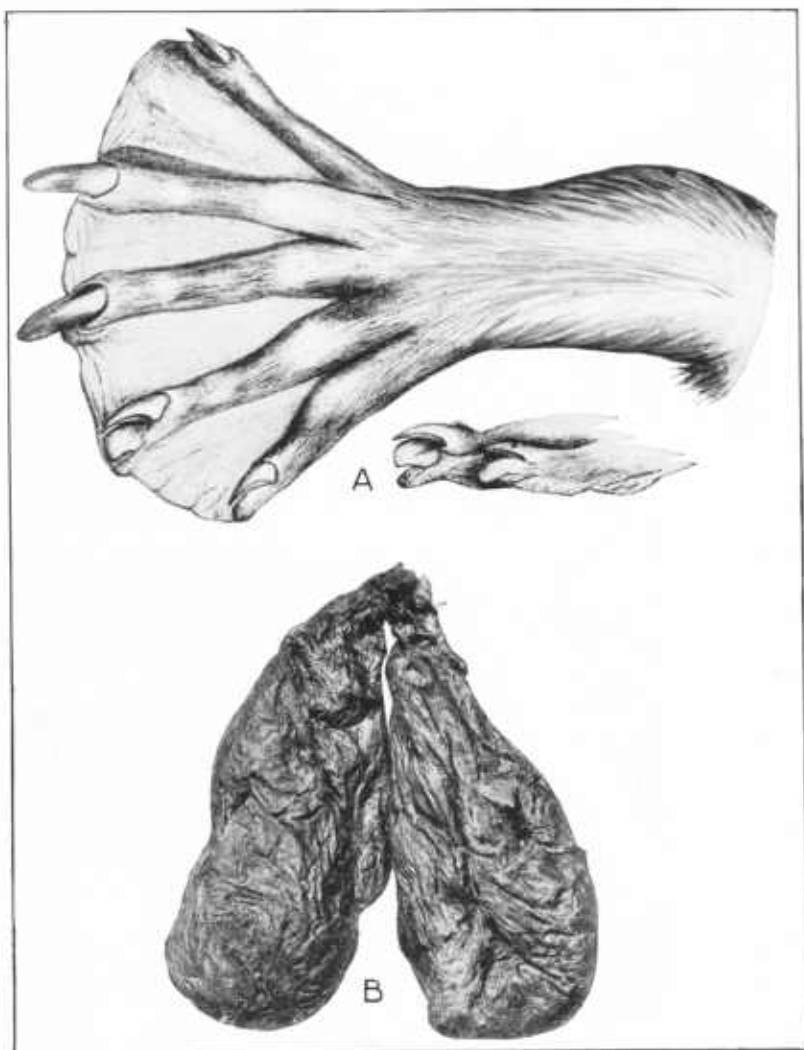
- | | |
|--|---|
| 1. <i>Castor canadensis canadensis</i> Kuhl,
Hudson Bay, Canada. | 9. <i>Castor canadensis subauratus</i> Taylor,
San Joaquin River, near Grayson,
Calif. |
| 2. <i>Castor canadensis missouriensis</i> Bailey,
Apple Creek, near Bismarck, N. Dak. | 10. <i>Castor canadensis shastensis</i> Taylor,
Hat Creek, a branch of Pit River,
near Cassel, Calif. |
| 3. <i>Castor canadensis michiganensis</i> Bailey,
Tahquamenaw River, Luce County,
Mich. | 11. <i>Castor canadensis pacificus</i> Rhoads, Lake
Keechelus, Kittitas County, Wash. |
| 4. <i>Castor caecator</i> Bangs. Near Bay St.
George, Newfoundland. | 12. <i>Castor canadensis leucodonta</i> Gray,
Vancouver Island, British Columbia. |
| 5. <i>Castor canadensis carolinensis</i> Rhoads,
Dan River, near Danbury, N. C. | 13. <i>Castor canadensis phaeus</i> Heller, Pleas-
ant Bay, Admiralty Island, Alaska. |
| 6. <i>Castor canadensis texensis</i> Bailey, Cum-
mings Creek, Colorado County, Tex. | 14. <i>Castor canadensis belugae</i> Taylor, Be-
luga River, Cook Inlet Region,
Alaska. |
| 7. <i>Castor canadensis mexicanus</i> Bailey,
Ruidoso Creek, near Ruidoso, N. Mex. | 15. <i>Castor canadensis baileyi</i> Nelson,
Humboldt River, near Winnemucca,
Nev. |
| 8. <i>Castor canadensis frondator</i> Mearns,
San Pedro River, Sonora, Mexico
(near international boundary). | |



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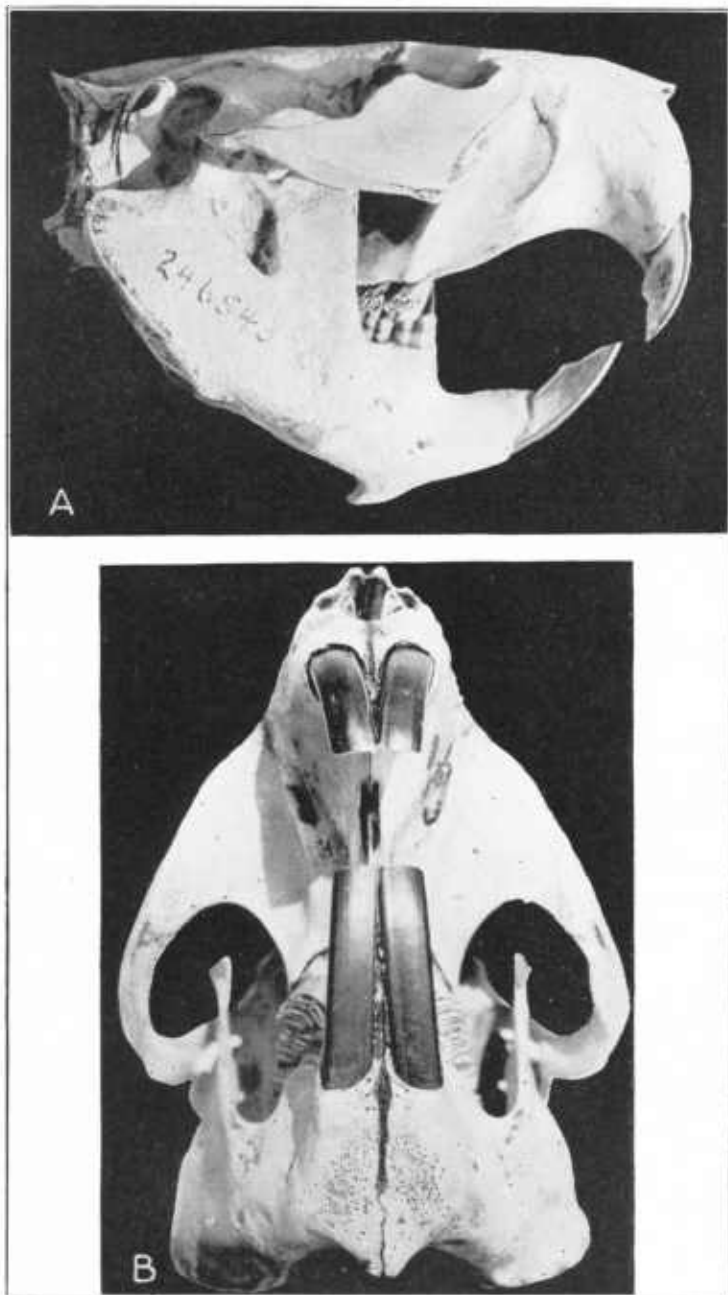
A 42-POUND MALE BEAVER

Taken in a "live-trap" and released in a field for photographing; this animal was gentle and easily handled from the first. The coarse outer hairs entirely hide the beautiful under fur. (Photograph by W. B. Campbell)



B1000M; B77M

- A, Wehbed hind foot of beaver, showing double combing claws on two inner toes. These claws are much used in combing out and keeping the fur smooth and in perfect condition and may well serve to remove any parasites that might get into the fur. The claws of the front feet also are used in combing and oiling the fur.
- B, Beaver pods, or musk glands, the castoreum of commerce. These two large sacks lying under the skin of the belly, just in front of the anus, are full of a waxy secretion with a lasting but not unpleasant odor. A few drops of the musk are squeezed from these glands to mark certain places along the shore, and though covered with fresh mud the deposit retains its odor for a long time. The contents of the dried pods have had a regular value for the manufacture of commercial perfumery and were formerly used in medicine. They are also used for attracting beavers and other animals to traps.



BEAVER SKULLS SHOWING CHISEL-LIKE INCISORS USED IN
CUTTING TREES

The large incisors are operated by powerful muscles attached to the massive bones of the skull, and the chisel edges are kept sharp by frequent scraping away of the soft inner dentine from the thin surface layer of hard enamel. Often when a beaver seems idle it can be heard sharpening its teeth by rubbing the edges together. The 16 highly specialized molars, or grinding teeth, are placed well back in the mouth. (Specimen No. 246543, Biological Survey collection, United States National Museum)



B29081 : B18491

A, Beaver slashings of poplar in northern Michigan. In a dense stand of timber often half the trees cut by beavers for food lodge where the trunks and branches can not be reeled and are wasted. A little assistance from a man with an ax will prevent this waste
 B, Mammoth cottonwood cut by beavers in Montana. Stump 46 inches in diameter photographed in Glacier National Park several years after the tree was felled. One of the largest trees known to have been cut down by beavers

face, and the sense of hearing is remarkably keen. The nostrils are small and valvular, closing under water and protecting the extensive nasal cavities back of them, and affording a keen sense of smell. The mouth, with hairy lips closing perpendicularly back of the broad, protruding, chisel-like incisors (pl. 3), also is valvular, so that the water can not enter it when the teeth are used in cutting or tearing up roots or sticks below the surface. The molars, or grinding teeth back of the lips, can be used for chewing while the lips are closed in front of them to keep out water.

The genital organs also are well protected from the water, being wholly concealed under the skin and opening into the general anal cloaca. Into this same cloaca opens a pair each of large musk glands (pl. 2, B) and oil glands lying under the skin of the belly just in front of the opening, in males at the sides of the penis.

Externally the sexes are not easily distinguished except that adult females have four conspicuous mammae arranged in a perfect square, two borne on each of the elongated mammary glands lying between the front legs. The stomach and intestines will accommodate large quantities of coarse food, and the liver is of unusual size and has large venous cavities that serve as a reservoir for storing oxygenized blood, a character that probably enables the beaver to remain under water for an unusual length of time.

WEIGHT AND SIZE

A 3-year-old female beaver, caught near Ashland, Wis., weighed 50 pounds and measured in total length 42.5 inches (1,080 millimeters); naked portion of tail, 11 inches (280 millimeters); hind foot, 7 inches (180 millimeters); inside length of ear, $1\frac{1}{4}$ inches (34 millimeters). Young at birth weigh about 1 pound each, when 3 weeks old $1\frac{1}{2}$ to 2 pounds, and when 6 weeks old about 4 pounds. Yearling beavers generally weigh 25 or 30 pounds; 2-year-olds 40 or 45 pounds, and 3-year-olds about 50 pounds. Older animals reach a weight of 60 or 70 pounds, and there are records of old and fat beavers weighing 100 and in one case 110 pounds.

INTELLIGENCE AND DISPOSITION

Beavers are widely famed woodcutters and builders and, though not endowed with the degree of intelligence often ascribed to them, are remarkably expert along their own lines and quick to adapt themselves to changed conditions, to meet unusual problems, or to take warning against new dangers. Patience, persistence, strength, and industry are more important factors in their work than quick wit or versatile mentality.

In their own families and colonies beavers are generally friendly and sociable. The young are especially playful and affectionate with one another and with anyone who wins their confidence. Strangers, whether beaver or human, are likely to be treated as enemies, and a strange beaver placed in an inclosure with others is sometimes attacked and even killed. The dispersal of a colony is generally due to a decrease in the easily accessible food supply or to need of more room as the families increase. There is no foundation for the common belief that the young are driven away from the colony when 2 years old.

SWIMMING

Both the form and the anatomy of the beaver show the adaptation of the animals to life in the water rather than on land. They are powerful, easy, and graceful swimmers, though ordinarily not rapid, paddling along with the large, webbed hind feet; but when alarmed they can swim under water as fast as an otter or a seal and with a somewhat similar undulatory motion of body and tail, an appendage that appears to be as effective as a high-speed propeller.

The question, Why is a beaver's tail flat and wide? is often asked, but it is only necessary to see it in use, tilted up, steering one way or the other, or striking downward as the animal dives from the surface, to understand its aquatic use. Especially is its full width and steering power taxed to the limit as the beaver swims, tuglike, by the side of a pole or log that it is towing to the house, dam, or food cache, with only the tail thrown out sideways to keep the swimmer from progressing in circles. On land the tail has other uses, but in the water it serves variously as rudder, propeller, and signal gun, its loud slaps on the surface of the water serving as warnings to friends or enemies.

In diving, beavers swim downward or in any direction under water. They swim long distances, half a mile or more, without appearing at the surface, and commonly remain submerged four or five minutes at a time, but much longer if alarmed. In winter, under heavy ice and mainly under water, they move about from the house or bank den to the food cache or to feeding grounds on the bottoms or banks of ponds or streams, getting air from bubbles under the ice, from air-filled chambers, or through air holes kept open to the surface.

WALKING

On land beavers walk with a slow, heavy, shuffling gait, dragging the tail on the ground or holding it slightly above and swaying it from side to side. At times one will gallop along as fast as a person at a slow run, but the young soon get tired and out of breath. If frightened, they will make a rush for cover or for the water, but at their best speed even adult animals can be easily outrun by a person. They seem to realize their limitations on land, and rarely are their cuttings or any signs of them seen far from water. Trees are commonly found cut as far back as 10 or 20 rods from the shore, but tracks, trails, or traces of beavers are rarely found farther from the water than that.

TREE CUTTING

In cutting trees each beaver usually works independently, although several sometimes work on the same tree. A small tree is generally cut through from one side, but as a rule a larger one is cut on two sides or all around. (Pls. 4, 5, and 6.) The chips are cut above and below and split out much as by a woodman's ax, and a large pile usually surrounds the base of a recently cut stump. The tree falls in the direction it happens to lean, which, along the shore, is generally toward the water. The bark is usually eaten from the chips before they are dropped on the ground. One old beaver in one night will fell a poplar tree 3 or 4 inches in diameter, cut it into

sections of 4 to 8 feet each, and drag it to the water. A larger tree will often withstand the attacks through several nights, and when down will provide work for the whole family or colony for a week or more in cutting, trimming, and carrying the sections of branches and upper trunk to the water. Trunks more than 5 inches in diameter are rarely cut up or moved from where they fall, unless lying in or near the water. Often trees a foot in diameter are cut down and occasionally those as large as $1\frac{1}{2}$ or 2 feet through. The largest the writer has ever seen cut was a balsam poplar in Montana, 46 inches across the stump. (Pl. 4, B.)

TREE CUTTING FOR FOOD

Poplars and cottonwoods, species of the genus *Populus*, are the favorite food of beavers, and few other trees are cut where these are to be had. Willows, birches, pin cherry, alders, and the bush maples (*Acer pennsylvanicum* and *A. spicatum*) come next. Many small bushes, as hazel, witchhobble, cornel, service berry, and raspberry, are cut for food, and under stress of necessity such hardwoods as birch, maple, ash, cherry, and even oak are felled, both for food and for building material. Such conifers as hemlock, spruce, balsam, and tamarack are rarely cut, and when they are it is mainly for building purposes, not for food. Pines are generally immune from the attacks of beavers, although a few yellow pines that they had cut have been seen; in one case the bark of small Norway and jack pines was fed upon where other food was not available. In Yellowstone Park beavers have cut a few lodgepole pines along Snake River, where no other timber is found.

DIGGING

Beavers do a great deal of digging, mainly under water. Their ponds are usually considerably deepened by the removal of mud and earth from the bottom for use in dam and house construction. Large burrows begun at the bottoms of ponds, lakes, or streams lead obliquely back into the banks and end in nest cavities above the water level, entered only from under water. These bank burrows are sometimes 40 or 50 feet long and large enough for a man to crawl into.

Extensive canals or waterways (pl. 6), for floating timber and for swimming through marshes or lowlands to a food supply, are dug and kept open while in use. These are often 2 feet wide and 1 or 2 feet deep, while old, long-used canals are even deeper and wider. Beavers rarely dig on the surface of the ground and never make a burrow with an exposed entrance; only under stress of confinement or alarm will they even scratch at the bottom of a wire fence when inclosed. An old beaver has been kept for three days on a lawn under an inverted box, and good-sized young have been kept for a month at a time in a wire-fence inclosure with the bottom wire resting on the surface of the ground.

TRANSPORTING MATERIALS

The carrying done by beavers is one of the most surprising parts of their remarkable work. In transporting wood on land they grasp

or hold it with their strong incisor teeth and with heads turned to one side drag heavy poles or good-sized branches. A stick or small branch is carried in the mouth clear of the ground or is partly carried and partly dragged. In the water a pole or small log is usually towed by the side, the teeth being fastened into the bark near the front end. At other times the log is grasped by the arms and front claws, while the beaver swims powerfully at the side and steers with its broad tail.

In carrying stones, of which the dams are sometimes largely built, the hands and arms are used. Stones 5 or 6 inches in diameter and weighing 8 or 10 pounds are commonly used, but as they are brought up from the bottom of the pond and carried under water, the water displaced serves to reduce the weight actually lifted. In carrying mud and small sticks from the bottom of the pond to be placed on the dam or house the beaver does not use its tail, but its hands and arms. (Pl. 7.) One will come up from the water carrying a huge armful, held tightly against its breast, and, rising on its strong hind legs, balanced by the tail pressed on the ground behind it, will walk in an upright position to the top of the house and deposit its load. As the slanting sides of the house are often a network of loose sticks, the strength and energy required to climb in the erect position and carry a heavy armful is amazing.

DAM CONSTRUCTION

In building dams beavers work from the upstream side. (Pl. 8, A.) Sticks, leaves, grass, sods, and mud are laid across the stream and are added to until the water flow is checked and the level begins to rise. Then, as it rises, sticks are pushed over the top and allowed to lie crisscross on the lower slope (pl. 9, B), bound in and securely held by mud and earth added to the top and upper slope until the dam is high and strong enough to hold water in the pond at the desired level, to be impervious to leaks, and to withstand the pressure of floods. The ends are extended as the water rises, and the final form and position of the dams are often the result of long tests of strength and endurance, experiments, failures, and changes; some of the larger dams are the work of many generations of beavers, and even where the builders were destroyed a century ago their dams often remain like solid breastworks below old beaver meadows.

HOUSE BUILDING

Beaver houses are sometimes started around burrows leading from deep water up through the edge of a marsh or the bank of a stream or pond (pl. 10, A); sometimes they rise from the bottom of the pond in open water 5 or 6 feet deep (pls. 9, A; 10, B), with sticks and mud piled up until the surface is reached, when the structure is continued upward until a living room can be inclosed above the water level. A new house is simple and not very tight, but before winter begins the walls must be thick and strong, if the house is to be used for living quarters. Sticks, usually first peeled for food, are laid crisscross in all directions and weighted down with mud, sods, plant roots, and the wet material dug up from the bottom and banks of the pond. (Pls. 7 and 8, B.)



BEAVERS AT WORK CUTTING LARGE TREES

B31 91 M

These as well as human wood choppers realize that the higher the stumps the smaller the trunk and the less the work of felling the tree, and large trees are usually cut as high up as possible. Small trees are often cut lower down. (Flashlight photographs by George Shiras, 3d)



120118

BEAVER CANAL

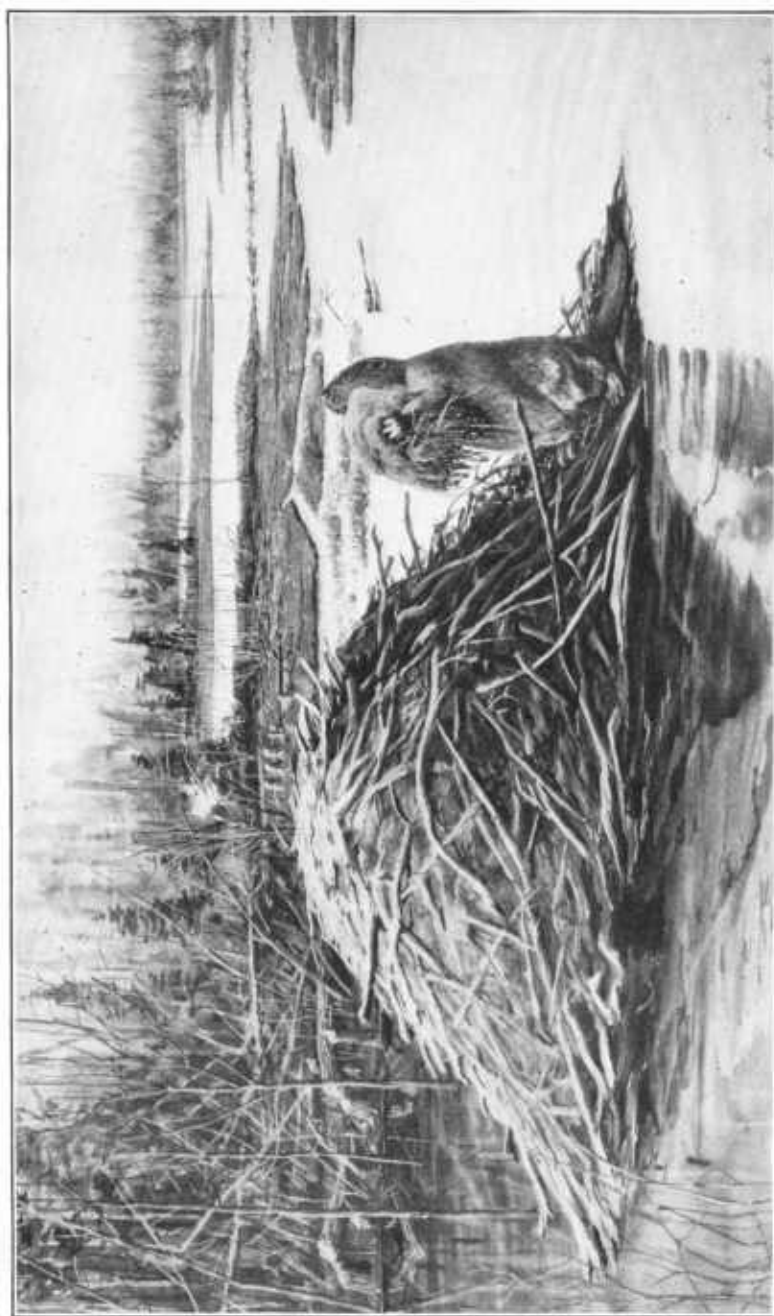
This canal leads from the pond to the source of food supply and is used for floating wood to the dam and house. (Photograph by Theo. H. Scheffer)



120119

YELLOW BIRCH

Fourteen inches in diameter, cut by beavers. The branches of birches are used for food and building material if aspens and other food are not to be had



B1879M

BEAVER HOUSE IN PROCESS OF CONSTRUCTION

Beavers bring up from the bottom of the ponds great armfuls of mud and trash, which they spread over the tops and sides of their houses, walking in an upright position as they carry the load in their arms. (From drawing by Louis Agassiz Fuertes)



B3129M; B3190M

A, Beaver repairing a break in dam. A freshly cut bush has been brought and placed in the break to hold in place the mud and turf to be added later.
 B, Beaver placing another stick on top of the house. Large sticks are carried or dragged up the sides of the house and late in fall are well covered with mud and trash to hold them securely in place and keep out the cold in winter. (Flashlight photographs taken by George Shiras, 3d)

A well-built house is dense and well fortified, the walls often 2 or 3 feet thick, of heavily reinforced construction. When well frozen the walls are hard and impenetrable even to the bear and the wolverene, which are credited with being old-time enemies of the beaver. Some houses have been estimated to be 7 feet high and 40 feet wide, but as a rule they extend 5 or 6 feet above the surface of the water and often as much below, and may be 20 or 30 feet wide at the water level.

The inner chamber is a simple cavity 3 to 5 feet wide and $1\frac{1}{2}$ to 3 feet high. It is partly cut out and shaped from the inside, with all sticks cut off flush with the surface on the inner wall; if more room is needed the chamber is enlarged from within. A semidry bed of grass, twigs, leaves, or shredded wood is made 2 or 3 inches above the water level and close to the water hole. One and occasionally two large passages lead from the floor to the water and come out under the bottom edges of the house 15 to 40 feet away, forming safe means of entrance and exit for the living room. If alarmed in the house the beavers dive into the water hole and may not show themselves at the surface within a quarter or half mile of the house, but usually a line of air bubbles escaping from their fur shows their course as they leave the vicinity of the house.

BREEDING

Beavers apparently begin breeding when 1 year old, as one or two embryos are often found in females of 25 to 30 pounds, but some may not breed the first year. At 2 years old, when weighing 40 or 45 pounds, they usually have four young, which seems to be the normal number for most beavers. There are, however, many records of six young and two or three of eight of embryos found in large, old females; but as the females have only two teats on each of the two large mammary glands, more than four young must take turns in nursing. So far as known, the sexes are about evenly divided in numbers.

The young are born in May and a few late litters apparently in June. There seems to be no evidence of more than one litter in a season, and there is no more than time for one litter to grow up and get ready for winter between May and November. The time of mating and the period of gestation are not definitely known.

The female beaver takes good care of the young and brings them tender plants and rootlets before they are old enough to leave the house. The male apparently remains away while the young are small, but in one large house in Wisconsin 2 females, 1 male, and 6 good-sized young were found in August. Like all rodents, beavers are polygamous, and the fact that fights among the males take place indicates that the older males strive for supremacy.

For the purpose of studying the young beavers in their nest, a beaver house was built of boards and placed in a pond in central Pennsylvania where it would be readily accessible. (Pl. 11, A.) It was made 4 feet square and 4 feet high, with a large hole in the floor in one corner and a narrow padlocked door at the back. A trapdoor was hinged to let down over the hole in the floor and was operated by a heavy wire running out through the side wall above the hole.

A nest box 20 inches square and a foot high with a hinged lid and a large hole in the side was placed in one corner and grass and twigs supplied for nest material. The house was placed on large stones at the edge of a small pond with the water just filling the hole in the floor but not covering the rest of the floor. A dam across a small stream had supplied the pond, around which a woven-wire beaver fence had been built inclosing an area about 50 by 100 feet in extent.

On May 5 a large old female beaver was taken in a live-trap and put in the beaver house with plenty of freshly cut aspen inside and out; the door was locked, and she was left to get acquainted with her new quarters. The trapdoor was closed down until evening and then quietly raised and fastened opened. On May 8 the warden, who was keeping close watch of the experimental house, reported young beavers. On examination the next day six heavily furred, perfect little beavers were found, with eyes wide open, lower incisors showing through and upper incisors so nearly through that the edges could be felt with the tip of the finger. Their tails were as perfectly formed as those of old beavers. They were active little animals and climbed about their mother in the nest box and even explored around the house. When 4 days old, one was seen to go down to the water hole and swim, but it was not able to dive or get its whole body under water as the dense, woolly fur floated the animal on top like a cork or a young duck, and only when about 2 weeks old did the first appear in the pond outside the house. The old beaver never showed signs of alarm or anger when anyone came into her house and stroked and petted her and her young. (Pl. 13, A and B.)

When 3 days old the smallest young weighed 14 ounces, the largest 17, and the others just a pound. When 23 days old two of average size weighed $1\frac{1}{2}$ pounds each, and when 6 weeks old their weights averaged a little more than $2\frac{1}{2}$ pounds each, varying from 32 to 48 ounces. (Pls. 12 and 13, A.) They were not up to normal weight, however, and the old beaver was thin from lack of sufficient quantity and variety of food for so large a family. Raising the young by hand is discussed in the section on feeding beavers, page 31.

At 6 weeks of age the young were not entirely weaned but were eating much green food, leaves, twigs, and bark, besides a daily ration of rolled oats. They were often observed while nursing, gathering around their mother as she half sat up or lay on her side, but only four could be accommodated at a time, and the smaller members of the family did not have a fair chance, with the larger and stronger ones clinging desperately to the nipples. The stronger ones were piglike in their efforts each to get all it could without regard for the others.

Old beavers are generally supposed to be voiceless, except for a loud blowing sound made when scared or angry, but one day when photographs were being taken of the old beaver and her six young the young became chilly in the cold spring water, and when their mother was out of sight they began crying and calling for her in distressed tones. Soon from the shade of the other bank where she was lying on the water, she raised her nose slightly above the surface and made several soft mooring notes, like a long *o-o-o-o* pronounced with the lips closed. At once recognizing the call, the young quickly swam across and climbed up on her back, where they sat, warming their cold

toes and tails in her fur and combing the water out of their hair, perfectly contented. Other vocal sounds may be made by beavers among themselves, but for a general expression of feeling and source of communication the slap of the tail on the water seems to take the place of a voice in the adults, although the young utter a variety of crying, complaining sounds.

Probably more books have been written on the beaver than on any other North American mammal, and in some the wildest fiction has been accepted as fact. Of the older books those by Hearne (4)² and Morgan (5) are especially good and reliable but are now rare. Of recent publications, Seton's (6) *Life-Histories of Northern Animals* contains an excellent account of beaver habits; and Warren's (7) *The Beaver* gives a detailed account of beaver life history and a comprehensive bibliography.

DAMAGE BY BEAVERS

CUTTING TREES

The trees cut by beavers for food³ and building material are generally of little value. They are mainly aspens, cottonwoods, birches, and pin cherries, or such shrubby woods as willows, alders, bush maples, hazels, and smaller bushes. Some choice trees, however, are occasionally cut along lake or stream fronts or in orchards near the water, and complaints of real damage and losses are at times registered; but in many cases the trees could be protected with strips of woven wire at a cost of a few cents each and the beavers left unmolested.

FLOODING

The most serious damage that beavers occasion by their dams results from the raising of water levels in streams, ponds, or lakes, namely, the flooding of the low ground and the killing of great areas of valuable forest trees. In places in the Adirondacks hundreds of acres of valuable white pine, cedar, spruce, balsam, hemlock, and tamarack have been killed by one beaver dam, and losses of many thousands of dollars inflicted on the landowners. (Pl. 14.) In places beavers have increased to such numbers that their activities menace timber and other valuable property and make it necessary locally to control, remove, or destroy them. In most cases their control is not difficult.

Beavers sometimes dam the outlet of a lake and by raising the water level a foot or two kill all the trees around the shores, leaving a wide border of dead and dying timber that transforms beautiful and valuable camp or cottage sites or summer resorts into desolate, worthless wastes. In a popular region, where camp and cottage sites are valued at several hundred or several thousand dollars each, the borders of a lake are often almost as valuable as city property, and such losses to landowners may reach a startling figure.

Other property losses are rarely so great, but are often annoying. The flooding of roads and trails sometimes interferes with or sus-

² Italic numbers in parentheses refer to "Literature cited," p. 38.

³ For food habits, see pp. 31-34.

pendes travel, delays lumbering or other business operations, or makes necessary tiresome detours and expensive repairs.

The flooding of railroad grades that cross low ground is sometimes serious and has sometimes interfered with the running of trains. Railroad culverts are frequently filled up by beavers (pl. 14) in order that they may take advantage of the grades for their dams, and section crews are kept busy clearing out sticks and mud to keep the stream channels open. There is sometimes actual danger to human life where the roadbed is softened by high water and the track rendered unstable. Exercising those rare traits of animal intelligence, thrift, and industry that make beavers unique among native mammals and of fascinating interest to nature lovers brings them into disrepute when these activities run counter to the economy of civilization, and in such cases the animals are mercilessly denounced, and many are killed. Ineffective methods of preventing their mischief cause much waste of time and unnecessary expense and only add to unfavorable local sentiment against them.

BEAVERS IN RELATION TO FISHES

It is often charged that beavers interfere with or injure fishing in streams where they build dams, and some persons still believe that they catch and eat fish. There is, however, no evidence of a beaver ever catching, killing, or eating any animal food. Of all captive beavers kept and studied and of young beavers raised, not one has been found that would touch or eat fish or meat in any form.

That beaver dams may in some cases, in slow or sluggish streams, spread out the water over marsh vegetation, forming shallow, warm ponds with decaying plants on the bottom quite unsuited to trout or fish of any kind is well known. Usually, however, such streams are not important fish streams before dammed by the beavers, and in course of time the water is freed from such decaying matter and is as satisfactory for fishes as before.

In cold, rapid streams, naturally well adapted to trout, beaver ponds rarely become sufficiently warm and stagnant to interfere with the comfort of fishes, and in most cases the deepening and extending of the water area above the dam increases the feeding and spawning area, providing deep pools and hiding places where the fishes thrive and escape detection long enough to grow up to larger size. In many streams both in the mountains and over a vast expanse of north country the trout fishing is greatly benefited by the presence of beavers, their dams, and ponds. Large trout and good fishing are commonly found in beaver ponds.

The claim often made that trout can not pass over beaver dams is shown in hundreds of cases to be erroneous. In spring floods and during summer freshets the water pours over the tops of beaver dams often in an almost unbroken stream, and then the fish can pass freely up or down the creek. In winter the fish are practically blocked by the dams, but the advantages of deeper water and larger feeding grounds afforded by the beaver ponds are so decidedly in favor of the fish as to account partly for their abundance in such places.

Not only is trout fishing often improved by the presence of beavers, but other fishes are sometimes attracted to their ponds. At a beaver



B3289M; B3292M

BEAVER DAMS, PONDS, AND HOUSES IN POTTER COUNTY, PA.

Recent activities of a few beavers, introduced from Canada in 1921, photographed in April, 1926. A, The sign near the house is a State conservation notice, warning persons not to disturb the beavers under severe penalty of the law. B, Beavers work from the upstream side in building a dam, pushing the sticks over the top and plastering the upper surface next to the water with mud



B3296M; B3290M

- A, Beaver house and food cache in northern Michigan. The branches extending into the water near the house mark the surface of a deep deposit of green cuttings stored for winter food by the beavers. (Photograph by Norman McClintock)
- B, A large new beaver house in southern Michigan. This well-built beaver house, 6 feet high and 30 feet wide at base, near Boyne City, Mich., was built in 1925 and 1926 by beavers planted on a fenced creek in 1923

colony near Luther, Mich., established in 1923, a small spring brook was dammed up and a pond several acres in extent formed. In places the water was 4 or 5 feet deep among the old logs and standing trees, and when visited in September, 1926, there were large numbers of black bass in the pond, many of which were of good size. Beaver culture might be associated with the production of fishes, waterfowl, and muskrats, a combination that would be more remunerative than any one of these industries by itself.

BEAVER CONTROL

Damage done by beavers can be prevented by proper methods of control, based on a knowledge of their habits. Before any area is stocked with them the character of the country should be studied and suitable areas mapped. The beavers should be restricted to these areas, and trapping allowed outside where the animals would naturally do damage. Beavers will not remain and thrive where there is no suitable food or water, or in deep streams and lakes with high or rocky shores, and they can not be permitted to carry on their opera-

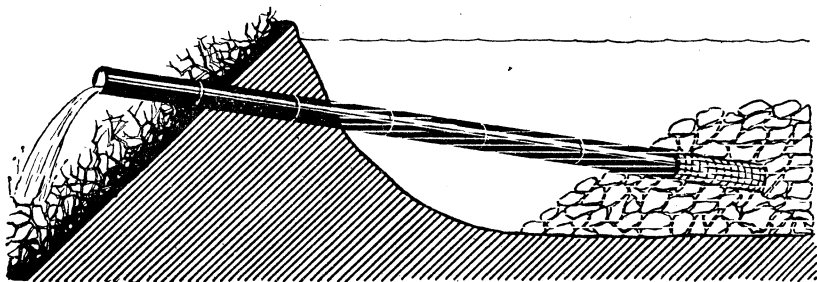


FIG. 2.—Pipe for lowering water in beaver pond. A 4 to 7 inch iron pipe with a cylinder of heavy wire mesh, inserted in the upstream end for a strainer, makes an effective drain for a beaver pond where it is necessary to lower the water only a foot or two. Larger pipes may be used or several small pipes laid together to carry a greater flow of water. Stovepipe can be temporarily used for such drainage

tions among small and closely cultivated farms, where they are sure to destroy property.

REGULATING THE LEVEL OF PONDS

It is useless to tear out or dynamite beaver dams, as the beavers, if active, will replace them almost as fast as destroyed. A simple method of lowering the water and keeping it at any desired level above the beaver dam by means of a drainage pipe has proved successful, so far as tested. Many attempts have failed through imperfect methods, as the beavers will stop up the pipes or pull them out if possible, displaying much intelligence and energy in checking the water flow. The pipes must be securely laid and fastened down and the intake thoroughly protected.

One or several pipes of sufficient size to carry the normal water flow should be laid through the dam with the outlet at the level at which the water is to be held, the other end terminating in a wire strainer, reaching down into deep water and covered with stones or logs. (Fig. 2.) When the water has been lowered to the desired level the intake end of the pipe must still be well under water so

that no marked current or water draft is perceptible at the surface. The pipes must also be securely held in place, so that they can not be pulled up, and the outlets must project a few feet beyond the lower face of the dam in order that they may not be covered with mud.

It will be necessary sometimes to pipe the water some distance below the dam to prevent the beavers from building a second dam to retain the water lost from the first. If the water is to be lowered to its original level a more elaborate system of drainage may be necessary, but in many cases lowering the water 1 or 2 feet will save the timber around the shores and still leave ample depth for the use of the beavers.

A simple drain may be made of three or more straight hardwood logs laid on a board or a piece of sheet iron through the dam. The logs should be laid in the same manner as the pipe, two of them slightly apart at the bottom and a third laid on top of them, their upper ends extending down into deep water. (Fig. 3.) Beavers rarely cut hardwood logs under water.

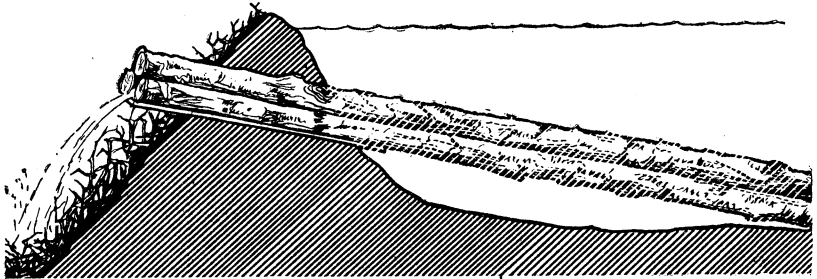


FIG. 3.—Three logs laid on a board or piece of sheet iron through the dam and sloping back into the pond, or more logs laid together to carry a greater water flow, in many places can be used to advantage to lower the level of the pond, in the same manner as that illustrated in Figure 2

To discourage beavers from damming a stream, a blind drain of stones, logs, or tiling can be used, so that when a dam is started the water will still flow underneath.

FENCING AGAINST BEAVERS

One of the simplest and most important means of beaver control is fencing. While it may not be possible greatly to restrict the freedom of the animals on large streams or lakes, it is not difficult to fence them on small streams or in lakes with small tributary streams. Advantage may be taken of their habit of not voluntarily walking many rods back from the water and of the fact that they will explore every possible stream and waterway, no matter how small, and even follow the bed of a tiny streamlet when dry in places in quest of new waters and a fresh food supply.

If a fence is constructed across small streams and out 20 or 30 rods on each side, beavers will usually not go beyond it. By placing fences across strategic points in streams and valley bottoms, such as between high ridges or impassable banks, the animals can be restricted to certain areas, sometimes to a single drainage system or to a lake basin, so that generally, on large areas involving a complete

stream system, fencing beavers should be less expensive than fencing dry-land stock. Fencing beaver farms is discussed on page 29.

TRAPPING FOR FUR

In most parts of the country beavers are kept down to meager numbers by trapping, and in any section where they are doing damage they can be promptly removed by providing an open season for taking them. In fact they are so easily trapped as to be one of the most difficult animals to protect. Except in large rivers and lakes, it is usually possible for experienced trappers to get all of them in a comparatively short time.

Trapping beavers for fur as practiced by amateurs is generally inefficient. Unless scarce and very shy, beavers are as easily caught as muskrats, but if the traps are not properly set and placed they will be found to contain only feet, the animal thus suffering needlessly and being lost to the trapper. If caught by a hind foot a beaver will sometimes be found in the trap in the morning, but if caught by a front foot the leg bones are quickly broken and the foot twisted and torn off.

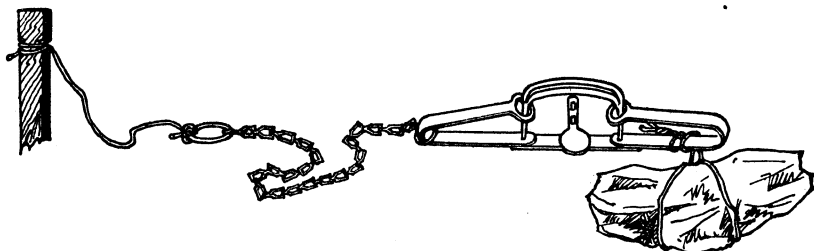


FIG. 4.—Weighted trap for drowning beavers. A stone weighing 20 to 30 pounds securely wired to the outer spring of the trap will sink and drown the beaver in a few minutes after it is caught, if the trap is set where the animal can reach deep water

WEIGHTED STEEL TRAPS

To obtain the best results with steel traps double-spring No. 3 traps should be used with a stone weighing not less than 20 pounds securely wired to the bottom or outer spring of each. (Fig. 4.) The trap should be set 6 or 8 inches below the surface of the water where the beaver lands at the shore, or on the dam, and always near a depth of at least 2 or 3 feet of water. A 15 or 20 foot wire attached at one end to the trap chain and at the other to a strong stake driven below the surface of the water will allow the beaver to drag the trap and stone into deep water, from which it can not rise to the surface for air, and in a few minutes, probably not more than 20 at most, it will be drowned.⁴ As trap and beaver are well hidden under water, other beavers are not frightened away, the fur is uninjured, and there is no danger of the carcass being torn or eaten by predatory animals. It is the simplest and safest method thus far devised for taking beavers in steel traps.

⁴ United States Deputy Game Warden Willett T. Grey, of Ashland, Wis., reported that he has frequently timed trapped beavers that stayed under water for 15 minutes; in one case 17 minutes elapsed before an animal was forced to come to the surface for air.

TRAP AND SLIDE POLE

Most trappers use a slide pole for fastening the trap and drowning the beaver—a long slender pole being thrust through the ring of the trap chain or a wire loop and slanted out into deep water and firmly bedded in the bottom. If properly arranged and slanted and in sufficient depth of water, the slide pole will act eventually to drown the beaver. Sometimes a wire or long chain is used instead of a pole, but this method is generally more difficult and less satisfactory than using the weighted trap.

OTHER METHODS

Success in trapping depends largely on a knowledge of beaver habits. The animals will be driven away if the houses and bank dens are disturbed. Steel traps should never be set in water not deep enough to drown the beavers. Other methods of trapping are mentioned in connection with capturing the animals alive for fur-farming purposes (pp. 23 and 27).

PUBLIC AND PRIVATE TRAPPING

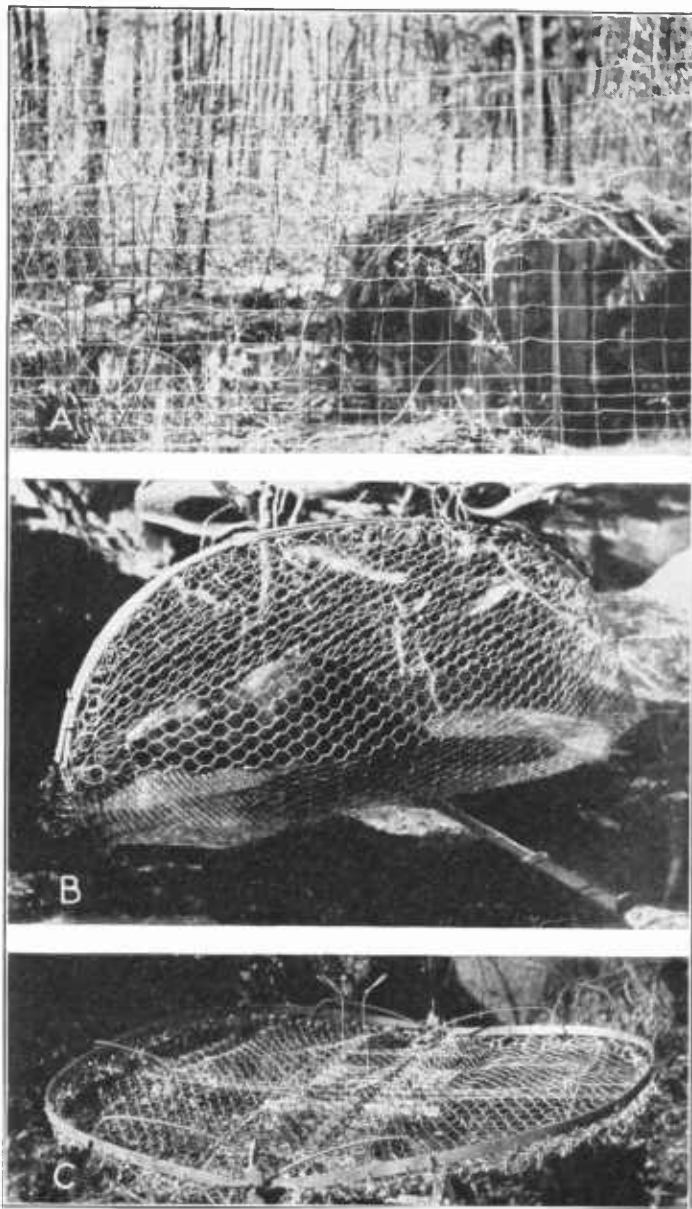
Under the present system of game laws it is difficult to protect beavers from illegal trapping, even on public lands and in public parks, and a radical change in sentiment toward the animals is desirable if they are to be utilized as valuable public or private property. If beavers can not be kept under control by regulating water levels about their dams, or by fencing, trapping in season for fur, or by trapping alive and transplanting, they can always be checked and their ravages ended by allowing them to be trapped on private lands with the permission and under the direction of the landowner. This would stop all complaints and meet all objections to the introduction of beavers and would also encourage beaver farming.

Eventually, when public lands are sufficiently stocked, limited trapping on them should be allowed, preferably by public employees under rigid rules and inspection. The beavers should be taken alive and selected for fur and only the darkest and best left for breeding stock. Many of the national and State forests, if stocked with the best beavers, should yield a valuable annual crop of high-grade fur.

NATURAL ENEMIES AND CHECKS

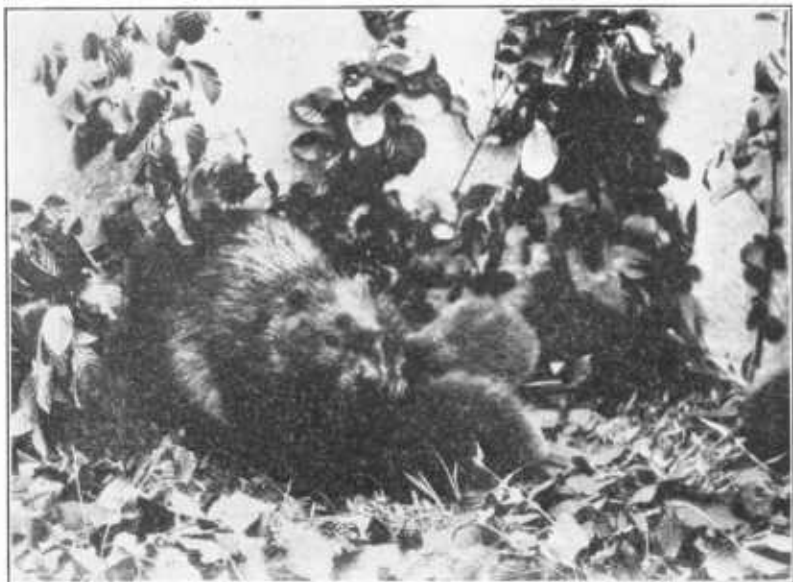
Natural enemies of beavers include bears, wolves, mountain lions, wolverenes, coyotes, and bobcats. Whether otters enter the houses and kill young beavers has not been satisfactorily determined, but there is reason for believing they do. Dogs are a serious menace to beaver farms when established in settled regions. Large snapping turtles could easily kill young beavers and should be kept out of beaver ponds.

Diseases seem to be unknown among beavers in a wild state, but in zoological parks the animals have been known to die of tuberculosis, and it would be a wise precaution to keep their surroundings in a sanitary condition. They are especially free from insect parasites, and their life in cold water seems to keep them in a healthy condition.



B2294M; B2306M; B2308M

- A, Artificial beaver house and pond in fenced inclosure near Laurelton, Pa. The old female beaver caught in a "live-trap" on April 5, 1926, and placed in this house gave birth to 6 young on April 8 and raised them comfortably in the quarters provided. (See mother and young in Plate 12, A)
- B, Beaver in cage trap. Sitting half under water, this large old beaver is waiting comfortably for its release early in the morning. Its later portrait is shown in Plate 1
- C, Trap set and ready to be placed. The trigger stands erect in the center of the set trap 10 to 12 inches high, so that when struck on any side by a swimming beaver it releases trigger bars and springs, and then the trap jaws close and lock above the captive animal



B3C95M; B23401; B23405

Above.—Old beaver with six young 11 days old. This old beaver raised her family of young in the artificial beaver house shown in Plate 11. (Photograph by Seth Gordon)
 Below.—“Bottle” beavers getting their breakfast. They are about 3 months old and weigh about 4 pounds each. The experiment with regular nursing bottles was successful

BEAVER CULTURE

That beavers are easily tamed has been conclusively shown, and experiments have been carried far enough to give much of the information needed to rear them in captivity. Beaver farming is still in the experimental stage, however, but all the experiments thus far carried on under the direction of the Biological Survey have proved encouraging. The transplanted animals show remarkable adaptability to new environment, and where food is abundant they make little effort to wander beyond barrier fences. Their increase in captivity, as nearly as can be determined, is normal or even in excess of that in their unrestricted and imperfectly protected wild range.

PROGRESS IN BEAVER FARMING

Since the publication in 1922 of the bulletin on the beaver (2) considerable information has been gathered on habits and methods of control, and improvements have been made in the trap for taking beavers alive. Two colonies established under State license in northern Michigan on wholly and partly fenced areas have shown a normal increase but have not yet become crowded, nor have the animals shown much inclination to wander.

On the inclosed area near Luther, Mich., one of the three beavers planted in September, 1923, escaped during the first autumn by digging under the fence where their dam had raised the water about a foot over the bottom wires. The animal wandered to a neighboring pond, but in about a week returned and was admitted to its original inclosure, and the hole under the fence was closed. When this colony was visited in September, 1925, the beavers occupying the inclosure must have numbered about a dozen to have accomplished the work they had done in cutting trees, eating bark, and building dams and houses. In no case had they attempted to dig under the fence on dry ground or to climb over it.

When visited again in September, 1926, the colony showed signs of further increase. Three large and two small beaver houses had been built. There were numerous bank burrows and dens, and a large number of trees had been cut for food. The 11-acre inclosure, only about 2 acres of which were on dry ground, was becoming well, if not over, grazed, and the beavers were scratching at the bottom of the fence in an effort to reach the more abundant vegetation outside. Within they had eaten most of the shrubby and small plants except ferns, wintergreen, and such weeds as were not relished. The grasses, sedges, and cat-tails were greatly thinned out, and the raspberry and blackberry bushes were reduced to stubble with all the foliage eaten off. Several small oaks, a few soft maples, and some birches had been cut and a large patch of bark eaten from a standing beech tree. There were still plenty of aspens, but a variety of food seemed to be desired. The whole place had a much-used appearance, and the trails along the inside of the fence showed to what extent the beavers were hungering for the abundant outside vegetation.

To get some idea of the number of beavers inhabiting this colony in September, 1926, two men, one on each side of the pond, watched all one evening for the animals and counted in all about a dozen large old beavers that came out while it was still light enough to

see them. These were swimming back and forth, and some were undoubtedly counted on both sides of the pond, but certainly seven and probably eight were seen at the same time. The young and yearling beavers did not come out before dark, although young had been heard crying in the houses earlier in the season.

The number of old beavers seen should indicate that the colony had at least three families of young, or a dozen young of the year, to which there should be added two families, or 8 yearlings, making in all a colony of about 25 at the lowest estimate. This number would considerably overstock the inclosure of 11 acres, even though favorably supplied with marsh and water plants as well as shore vegetation. The owner of the place was then building a larger inclosure to include another lake and marsh and comprise an area of about 100 acres, into which the beavers were soon released.

The partially fenced area near Boyne City, where four beavers, an old male and a female with two young, were placed in September, 1923, on a creek above a 30-rod cross fence, was revisited in September, 1925. The actual number of beavers could not be learned, but the cutting and storing food and building dams and houses they had done, indicated that there were certainly more than a dozen at work. One pair or family had wandered a short distance from the head of the creek across to the head of a neighboring creek, where they had built dams and a house and were comfortably settled in ideal surroundings. A fence was to be built across this creek below the colony to prevent their wandering farther downstream and to insure the stocking of both creeks. To aid further in protecting this colony the land was made a State game refuge, marked with notices and warnings regarding trespass.

When the colony was again visited, in September, 1926, there was ample evidence of still further increase. Of the five or six beaver houses, one was the largest structure of its kind being completed in preparation for the coming winter. (Pl. 10, B.) Also there were numerous bank burrows along the edges of the 40-acre pond, which was held to a good depth by a well-kept dam about 30 rods long. Great numbers of aspens had been cut for food, and the area of fully 1,000 acres of good beaver pasture available for this colony should prevent crowding here for several years. In a brief examination no actual count of the animals could be made, but from the houses, dams, and other work it seemed evident that there were as many as 25 beavers in this colony, while the family that had moved over to the next creek, and built a house and dam there, probably numbered 5 or 6 individuals. The cross fence below this colony of beavers, as described on page 30, effectually prevented their going down the creek.

In Potter County, Pa., four beavers were introduced by the conservation commission from Ontario, Canada, in 1921 and released near Hull, on the headwaters of Sinnamahoning Creek. When this region was visited in April, 1925, the animals had spread to several branches of the creek and had built 15 houses (pl. 9, A) and numerous bank burrows and dams (pl. 9, B); their numbers were estimated as about 50 by the game wardens, who had been carefully watching them. Some of them were caught in a live-trap and placed in other suitable localities for the purpose of stocking the State wild

lands with beavers in places where they would find food and living conditions without doing any damage.

When visited again in April, 1926, the Potter County beavers showed signs of a marked increase, at least twice as many as in the previous year and a slight widening of range. During the year 16 beavers were caught in live-traps and moved to other streams for restocking purposes, and 3 were known to have been accidentally killed, but there were still in the original colony 16 main dams and about 22 occupied houses. From observations of several wardens who had been watching the animals closely throughout the year and from signs of beaver activities, it was estimated that there were 75 in the colony. With those removed and their progeny, this would indicate at least a 100 per cent increase during the year.

Two large old females each had six young in the spring of 1926, and two families of five young each were noted during the previous summer by the local wardens. Apparently, litters of this size are not so unusual as was formerly supposed.

In 1901, the Province of Ontario presented the Governor of Minnesota with two pairs of young beavers for stocking the State park at Itasca Lake. One of the males was killed in transit, so that only one male and two females reached the lake, and these were released in a favorable locality. For the next 22 years these beavers were under the control and close observation of W. T. Cox, then State forester of Minnesota and since superintendent of the Upper Mississippi River Wild Life and Fish Refuge, who kindly placed his full notes at the writer's disposal. By 1912 there were 50 houses, and beavers estimated to number 250 in Itasca Park, in spite of some poaching. A careful count in 1914 showed 92 inhabited houses, indicating about 460 beavers. In 1916 the count showed 127 used houses, and the beaver population was estimated at 635 or more. Trapping under permit was begun in the spring of 1917, but the increase was not all taken, as is shown by the estimates of 750 beavers in 1918 and 1,000 in 1921. The trapping, under careful supervision, was done when the lakes began to open up around the edges early in spring, and by setting the traps at long distances from the houses mainly old male beavers were caught. The few adult females taken contained usually four embryos that apparently would have been born about the 1st of May, while some yearling females would have given birth to smaller families about the 1st of July. By this discrepancy in breeding time of old and young females, Mr. Cox correctly accounts for the fact that both large and small young are taken in fall, which trappers commonly explain by the theory that two litters of young are raised in a season by one female.

From 10 to 20 per cent of the beavers left the park each year, according to estimates made by Mr. Cox, in addition to those caught legally or illegally, so that the rate of increase was not what could be expected in a privately owned and controlled beaver farm. Still, it furnishes valuable data on which to base an estimate of their rate of increase. Mr. Cox concludes his notes with the following expression of opinion based on his years of experience and training as a forester:

The beaver is such a benefactor in preserving the forests from fire and so valuable for its fur that its extermination in this State would be little short of a calamity. I have great faith in the beaver as an asset wherever there is

suitable woodland to furnish food and lakes, streams, and marshes to provide a proper habitat. The possibilities for extensive beaver culture are almost unlimited.

Ress Philips, formerly supervisor of the Pike National Forest, Colorado, in a letter to Smith Riley, formerly of the Biological Survey, states that in the summer of 1925 two beavers came to the small pond in the center of Green Mountain Falls, on Cascade Creek, above Colorado Springs and began to cut willows along the bank. Some of the villagers wanted to kill them, but others, appreciating the interest of a beaver colony at their doors, objected and hauled in aspens for them. The beavers soon became tame and would play and eat bread and crackers within a few feet of visitors. The animals built a substantial house on an island in a pond beside the band stand and evidently intended to remain as long as welcome.

Young beavers are easily tamed and may prove to be the best stock to start with, but even adults will become thoroughly tame and sufficiently gentle to be handled by those accustomed to animals. (Pl. 13, B.) With plenty of clean water, good sleeping quarters, and a suitable food supply, they can be kept on either large or small areas, where they should thrive and multiply satisfactorily.

VALUE OF FUR

The first question in regard to raising any animal for fur is whether the price its pelt will bring will be sufficient to pay the cost of raising and yield a profit. Beaver fur has been generally considered low priced, and some of it is, but few animals vary more widely in value according to geographic areas. Skins from the lower Colorado River and Rio Grande are the palest, lightest furred, and lowest priced, the lowest recent quotations being \$6 to \$8 each; the heavy-furred, dark-brown skins from Canada and Alaska in 1926 brought \$25 to \$37; choice skins from northern Wisconsin have sold as high as \$50 each. Were actual values of beauty, warmth, and wear considered, choice black beaver should bring an even higher price. Obviously, if beaver farming is to be a success, only the choicest stock should be selected to start with, and this should be improved by selective breeding until the most beautiful fur of the highest grade and highest price is obtained.

SITE, SIZE, AND COST OF BEAVER FARMS

The longest, heaviest fur is produced in cold climates, and the best beaver country is found in the Canadian and Hudsonian Zones, regions usually of relatively little agricultural value. In the United States these zones cover parts of the northern tier of States and extend farther south in parts of the colder mountain regions. The range of the aspen or poplar tree (*Populus tremuloides* and varieties) is a good index to suitable beaver climate and conditions. The aspen also furnishes the best beaver food and at present has relatively little commercial value. It grows naturally across the northern part of the continent from the barren grounds of Canada and Alaska, south to the northern parts of the United States and, in the mountains, to northern Mexico. Wherever this tree is found, if other conditions are favorable, beaver farming should be success-



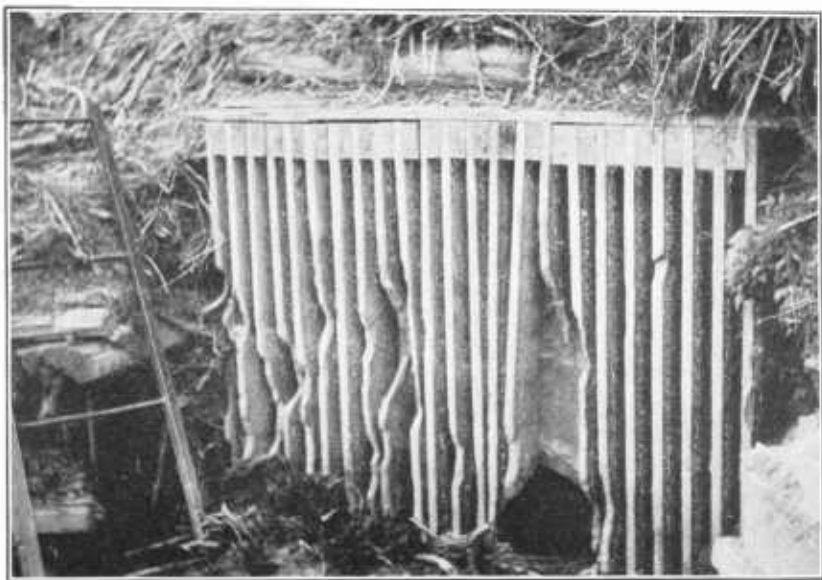
A. Baby beavers are gentle and affectionate. These animals would be delightful playmates for children if they did not sleep most of the day and carry on their activities mostly at night. (Photograph by Seth Gordon)



B. A 55-pound beaver recently captured in a "live-trap." This old female beaver, taken in Potter County, Pa., where they were introduced from Canada in 1921, is as quiet and gentle as any domestic animal.

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Above.—Timber killed by beavers. Part of a large area of spruce, tamarack, and white pine killed by flooding. The water was raised about 2 feet, and the ensuing loss of timber was estimated at between \$5,000 and \$6,000. Most of this loss could have been prevented by lowering the water at the dam 1 or 2 feet, in the way illustrated in Figures 2 and 3 (pp. 13 and 14), at an expense of not more than \$25.

Below.—Railroad culvert screen cut by beavers. This culvert was repeatedly closed by beavers and the water raised above the roadbed. About a ton of sticks and mud had been taken out and an iron ladder was kept there for the use of the section crew, who removed the debris every few days. A proper drain would have prevented the trouble.

ful. Should beaver farming on suitable areas prove a profitable enterprise, it would make remunerative considerable areas of now unproductive lands. The possibilities of success under proper conditions render beaver farming an attractive field for well-managed experiments.

Much of the best beaver country is in localities where, after the original timber has been lumbered off and the ground burned over, thickets of aspen and pin cherry have sprung up as second growth. Such land is generally considered almost worthless, but it might support a large beaver population and could be successfully handled on either a large or a small scale. A small fur farm, where detailed attention can be given to the animals, is likely to prove most successful at first, and it can be extended when management practices are fully mastered.

A small natural pond, lake, or creek that could be fenced above and below to hold the beavers would make a good site for a beaver farm, but if such sites are not to be had at the start a small artificial basin scraped out and filled with water from a spring, or even pumped from a well, would do for a beginning. The two essentials are water and food. A long section of stream valley, the headwaters basin of a stream system, or a lake or chain of lakes would afford ideal locations for extensive beaver farms.

A depth of at least 5 feet of water in beaver ponds is needed at all times to afford the animals a free swimming place under the ice in winter and safe cover from enemies in summer. In almost any small stream with a permanent flow beavers will obtain the desired depth by building dams across the creek at strategic points. Usually the ponds are considerably deepened by digging the mud from the bottom for constructing the dams, while deep canals are often dug to the houses or the bank burrows. Beavers will readily adapt themselves to almost any condition if food and water are available.

Questions as to how much land is needed for a beaver farm, what it will cost, and where it can be had, can not be definitely answered. In a general way, however, it can be said that 500 to 1,000 acres of wild and otherwise worthless northland containing small lakes, streams, and the right kind of forest growth should make a good beaver farm. Where only a few beavers can be obtained to start with, however, a beginning may be made on 1 or a few acres, and the larger area can be added later as the animals increase. Good beaver land can be found in large areas over northern New England, New York, the mountainous parts of Pennsylvania, northern Michigan, Wisconsin, Minnesota, throughout much of the Rocky Mountain country, in the mountains of Oregon and Washington, and in vast areas of Canada and Alaska.

Much of the best beaver land has reverted to the States as not worth paying taxes on for lumber or agricultural purposes. Such land before it is relinquished can sometimes be bought at \$1 an acre after the native timber has been removed. Other extensive tracts are valued at \$3 to \$5 an acre, and others according to quality of soil and timber and nearness to roads and towns up to \$10 and \$15.

A large investment in land is not advised as a start for a beaver farm unless a considerable number of beavers that can be used as breeding stock are on the land at the time of purchase. A small

colony will require five to eight years to increase sufficiently to yield any return on the investment, and most of the land during these years will bring no income, even to cover taxes. When beaver farming becomes an established industry, some methods will doubtless be developed for leasing public lands for the purpose on terms fair to fur farmers of little capital, and remunerative to the State or Federal Government.

SELECTING BREEDING STOCK

So far as known, the darkest and richest-colored beaver fur is found along the south shore of Lake Superior, in northern Michigan and Wisconsin.⁵ In this region of heavy forest and deep snows the outer hairs of the animals are dark brown and the underfur almost black. When tanned and plucked, the skins are beautiful, and made up into wearing apparel, they almost equal sea otter in depth of fur and richness of color. They are decidedly superior to the Canadian and Alaskan skins, which have generally been considered the best and highest priced, but they have been rarely quoted in the fur markets, as for many years the beavers of the region south of Lake Superior have been carefully protected, their capture, except for scientific specimens, being prohibited. They are now fairly abundant in this region, but an open season would greatly reduce their numbers. The disastrous effect of even a short open season where beavers have become tame has been demonstrated many times, and even the bungling methods of amateur trappers sometimes leave only a few crippled beavers slowly to restock the waters. If the beavers of this region are to be trapped it should certainly be only as live animals for breeding stock.

If a choice dark variety of beaver is bred successfully it would probably not be necessary to sell the skins for many years, as the demand for breeding stock should make the price for live animals much greater than their fur value. If a reasonably satisfactory maximum price could be established for live beavers the industry would thrive, but wildly speculative prices, such as black foxes have at times brought, would seriously handicap the enterprise. This danger is not imminent, however, as the source of supply is ample, and there is no possibility of a cornered market of breeding stock.

There is always a distinct advantage in having fur raised under control, for superior prices can be obtained by marketing it when at its very prime and by selecting the animals at the right age and season and in the best condition for quality of fur. Relatively little perfectly prime beaver fur is taken in the United States, even in the open season.

To improve the stock by selective breeding, the choicest animals should be reserved for breeders and all inferior ones marketed for fur. For convenience in handling the animals, corral traps (see p. 27) should be used. Suitable corrals or feeding yards can be kept in permanent use in order that the beavers may be inclosed at any time while feeding. The more accustomed they become to the presence and voices of people the less nervous and alarmed will they be when it is necessary to capture and handle them.

⁵ The beaver inhabiting this area was described as a new subspecies, the woods beaver (*Castor canadensis michiganensis* Bailey), from Tahquamenaw River, Mich., (1, p. 192).

CAPTURING STOCK FOR PROPAGATION

For quicker adaption of stock to semidomestication it is well to start with young beavers, which may be taken at any time after they are 5 weeks old. Apparently they do not leave the house or bank den where born until they are at least that age, or sometime in June or July. They will then weight 2 to 4 pounds and are easily caught in the water from a boat. In some places they can be scooped up in wire-mesh dip nets as they come from the house through their underwater canals, but they are more likely to be first seen swimming with heads just above water not far from the house. In such cases, two persons in a canoe, one in the stern to paddle and one in the bow to watch, can easily catch them. As they dive, the direction should be noted, the boat should be driven beyond the spot, and the water watched on all sides for the next appearance. Young beavers will not remain under water long, rarely more than two or three minutes, and after several swims they become tired and are readily approached and picked up by the tail as they come to the surface and pause for breath. They do not attempt to bite, and if carefully handled are gentle and quiet from the first.

It is usually possible to locate young beavers in a house by listening, as they habitually cry a great deal, especially when hungry or disturbed. When old enough to come out regularly for food they can be seen before dark swimming about near their house or a little way out in the water. It is best not to disturb the houses unless young are known to be in them, but if great care is taken not to injure a house and to close securely any openings made, the young will not usually abandon it. If bank dens could be located, the young could probably be caught in them, but where there is no over-ground house to mark the spot and the underwater doorways are well hidden it is difficult to take them. Where possible, however, it is better to use the live-trap in capturing even the young beavers, so as not to disturb the houses.

As a result of recent experiments in taking beavers alive the beaver trap and trapping methods described in Department Bulletin No. 1078 (2) have been markedly improved. A knowledge of the most satisfactory apparatus and of the best methods devised for capturing beavers alive is important when it becomes necessary to transport the animals to areas where they will not be detrimental to agriculture or to other interests of man, and where they may maintain their numbers and thus perpetuate the supply of fur for future generations.

BIOLOGICAL SURVEY BEAVER TRAP

The beaver trap devised by the Biological Survey has been improved and strengthened until now it is entirely satisfactory in operation.* The new trap (fig. 5 and pl. 11, B and C) has been thoroughly tested, and in March, 1926, a patent was obtained for the writer by the Department of Agriculture and dedicated to the use of the people of the United States. It is designed chiefly for capturing beavers alive for control and propagation, and can be manufactured by anyone for personal use or for sale. The specifications

*The dimensions here given are slightly different from those published in Department Bulletin No. 1078 (2) and in Miscellaneous Circular No. 69 (3).

and directions that follow should enable any machinist or practical mechanic to make the trap at an expense of about \$7 for materials, in small lots, and about \$6 for shopwork. The completed trap weighs about 28 pounds.

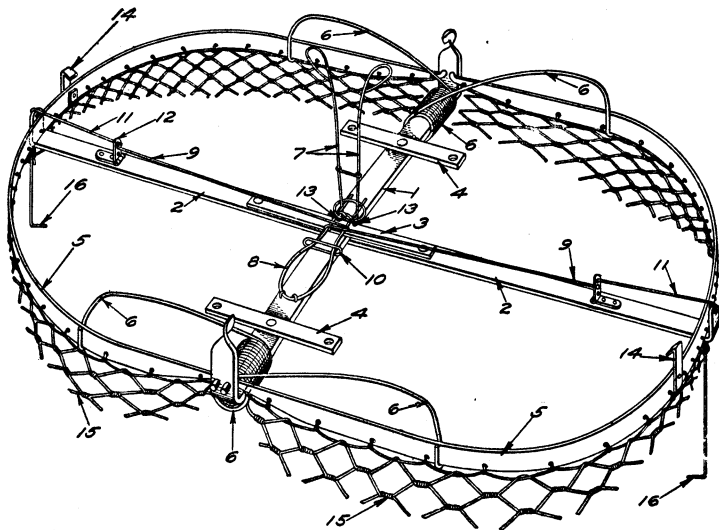


FIG. 5.--Details of construction of Biological Survey beaver trap

- | | | |
|--------------------|--------------------------|-------------------|
| 1. Base bar. | 7. Trigger. | 13. Trigger grip. |
| 2. Crossbar. | 8. Trigger spring. | 14. Clasp hook. |
| 3. Top crossbar. | 9. Trigger wire. | 15. Wire mesh. |
| 4. Short crossbar. | 10. Trigger collar. | 16. Safety hook. |
| 5. Trap jaw. | 11. Trigger bar. | |
| 6. Coil spring. | 12. Hinged trigger loop. | |

MATERIAL REQUIRED

(Italic figures in parentheses refer to the numbers of the parts in fig. 5)

- 1 cold-rolled steel bar $1\frac{1}{4}$ by $\frac{1}{4}$ by 50 inches, for base bar (1).
- 2 cold-rolled steel bars each $\frac{7}{8}$ by $\frac{3}{16}$ by $81\frac{1}{2}$ inches, for trap jaws (5).
- 1 piece of flat iron $1\frac{1}{4}$ by $\frac{1}{4}$ by 54 inches, for crossbar (2).
- 1 piece of flat iron 1 by $\frac{1}{4}$ by 13 inches, for top crossbar (3).
- 2 pieces of flat iron each 1 by $\frac{1}{4}$ by 11 inches, for short crossbars (4).
- 2 pieces of strap brass each $\frac{3}{4}$ by $\frac{1}{8}$ by 6 inches, for clasping hooks (14).
- 2 pieces of No. 3[†] ($\frac{1}{4}$ -inch) oil-tempered spring-steel wire, each 8 feet long, for making the two coil springs (6).
- 1 piece of No. 6[†] oil-tempered spring-steel wire, 2 feet long, for trigger spring (8).
- 2 pieces of No. 6 oil-tempered spring-steel wire, each 10 inches long, for trigger bars (11).
- 1 piece of 1-inch mesh, No. 16[†] woven wire, galvanized before weaving, 48 inches long, from a roll 60 inches wide, for bottom and sides of trap (15).
- 50 feet of No. 15[†] galvanized malleable wire, for lacing and linking wire mesh sides and floor of trap to jaws and bottom, for making trigger wires (9), trigger collar (10), and safety hooks (16), and for fastening trigger spring.
- 32 inches of No. 12 galvanized wire, for trigger (7).
- 5 quarter-inch bolts, 4 of them $\frac{3}{4}$ inch long and 1, 1 inch long, for attaching crossbars to base bar.
- 1 pair of $1\frac{1}{2}$ -inch brass hinges with strap-shaped sides, and two screw holes in each, for trigger loop (12).

[†] All wire sizes are standard American gauge.

SHOPWORK

Drill $\frac{7}{16}$ -inch holes as follows: Two side by side, 3 inches from each end of base bar; and one one-fourth inch from each end of long crossbar.

Drill $\frac{1}{4}$ -inch holes as follows: One in center and one at 12 inches from each end of base bar; one in center and one 6 inches each side of center of main crossbar; one in center and one one-half inch from each end of 13-inch crossbar; and one in center and one one-fourth inch from each end of each 11-inch crossbar.

Drill $\frac{3}{16}$ -inch holes as follows: At 3-inch intervals along flat jaws, one-eighth inch from outer edge and to about 4 inches of the ends; one in middle of one trap-jaw bar 6 inches to right of center and one in the other 6 inches to left of center of trap; two in middle of main crossbar about 7 and 8 inches from each end, for hinges for trigger loops; these last had best be smaller and be bored when hinges and trigger bars are being adjusted.

Heat and turn up ends of base bar at right angles, 4 inches from ends, then heat and make a short quarter twist 2 inches from tips of turned-up ends, and thin the inner edge of twisted section to one-eighth inch thickness where it comes between trap jaws, to keep them from passing the center.

Heat and turn up at right angles the ends of long crossbar, $1\frac{1}{2}$ inches from tips.

Heat and round and turn out at right angles $1\frac{1}{2}$ -inch tips on each end of the two flat steel bars for jaws, to fit the holes at the ends of the base bar. In rounding the ends of the jaw strips the tapering should be on the outer edge, so that the tips may be almost in line with the inner edge.

Wrap No. 3 wire for coil springs twelve and one-fourth times closely around an iron pipe or hardwood rod $1\frac{1}{2}$ inches in diameter, leaving one end about 16 and the other about 14 inches long, with the two ends at right angles when open and free. The springs will unwind one full turn when released, leaving eleven and one-fourth turns. Heat and bend the tips of free ends of springs to form hooks to clasp the jaws when crossed.

Bend the 24-inch No. 6 wire in form of hairpin, for the trigger spring, about 10 inches long and 3 inches wide at the open end.

Bend 1-inch loop in one end of each of two 10-inch No. 6 wires, for trigger bars.

ASSEMBLING THE PARTS

Bolt longest crossbar at right angles under base bar with the 13-inch crossbar above, with a 1-inch bolt through center and two $\frac{3}{4}$ -inch bolts through holes in ends of 13-inch bar and corresponding holes in long crossbar.

Fasten the two 11-inch short crossbars across top of base bar, with a $\frac{3}{4}$ -inch bolt through the middle of each and through the hole 9 inches from the upright ends, to support bottom of trap.

Slip coil spring over bent-up ends of base bar until below right-angle bend, with shortest arm next to jaws.

Bend jaws in a depressed semicircle around wooden form so that they will fit together when in place and reach just inside of bent-up tips of crossbar when open.

Spring bent-up tips of jaws into holes in turned-up ends of base bar, and make all necessary corrections of curving so that jaws will fit together.

Clasp shorter end of spring on one jaw, and use pressure to bring the longer end across to clasp the other jaw in an upright position.

Weave 3-inch half-hitch loops of No. 15 wire through holes drilled 3 inches apart in the trap jaws, the loops outward, and twist the clasping parts down tight to jaws.

Hook the 1-inch loop at one end of each of the 10-inch No. 6 steel-wire trigger bars downward into holes at ends of main crossbar, and close up loops so they work freely.

Rivet the two small brass hinges at the holes 7 and 8 inches from ends of main crossbars, so that the free ends will stand upright about 7 inches from the turned-up ends of bars. A small hole should be first punched or drilled near the middle of the free part of each hinge, and the terminal screw hole enlarged to form a loop that will admit the tip of the trigger bar loosely.

Make the trigger of No. 12 galvanized wire, bent in the middle into a 2-inch circle, with downward projections one-fourth inch below the circle to grip arms of spring (13, in fig. 5) and hold them half closed, and with the two free arms standing erect, 11 inches high, the ends looped to desired height. Pushing this trigger in any direction lifts the downward projections (grips) of the circle, releases the trigger spring, and springs the trap.

Trim the No. 16 woven wire for sides and bottom to fit inside of arch of closed trap jaws and wire the bottom securely to top of base bar at ends and middle and to ends of short crossbars. The inner arm of spring should be thrust up through an opening in the mesh.

Wire closed end of trigger spring to wire mesh of floor of trap, in line with base bar, the free ends extending 2½ inches beyond center. A wire loop or collar of No. 15 wire passed over both arms of trigger spring near middle and under wire mesh will hold it in place and prevent its opening too far.

Attach a No. 15 galvanized wire to each arm of the trigger spring at center line of trap, making the two wires cross and reach to middle hole of hinged trigger loops on opposite sides of trap. Fasten the ends of the crossed trigger wires connected with trigger spring through the middle holes in the free part of the hinge so that when the sides of the trigger spring are open the upright trigger loops will not reach the tips of the trigger bars, and when the trigger spring is held together by the trigger grips the loops will remain on the ends of trigger bars to hold down the trap jaws.

Fasten upper edges of woven-wire side pieces to loops along trap jaws, using No. 15 galvanized wire and lacing the edges together so as to give flexibility to sides of trap.

Rivet a flat hook (14, in fig. 5) loosely on top of each trap jaw in the holes drilled 6 inches from middle of trap, facing the hooks opposite ways, so that they will clasp the closed jaws and the trap can not be opened from within. (Pl. 11, B.)

OPERATING THE TRAP

Open trap jaws part way and place trigger on trigger spring to hold it half closed and release tension on trigger loops.

Bring down one jaw and secure it in place by trigger bar and hinged trigger loop, holding loop upright by a safety hook (16, in fig. 5) to keep trap from springing. Repeat the operation with other jaw. (Pl. 11, C.)

Lift trap by base bar or crossbar underneath, and carry edge up to the water where it is to be placed, or, if set from a boat, slide the trap over one side until the lower edge rests on the bottom, then lower as boat is pushed back, leaving the trap in desired position.

Release the safety hooks from trigger loops as last act when trap is satisfactorily placed.

Set trap in beaver canal, in creek or feeding place, or in front of landing place, in water about 1 foot deep, either on the bottom or on stones or forked stakes or crossbars, with tip of trigger about 2 inches below surface of water. The trigger can be bent over or straightened up to desired height for different depths of water, varying from 10 to 16 inches.

Scatter aspen twigs back of trap, so that to get them the beaver will have to swim against the trigger, thus springing the trap. The trap may also be sprung by fastening one end of an aspen twig to the trigger and letting the other project above the water so that the trigger will be moved when the twig is pulled by the beaver.

A captive beaver can be carried to camp inside the trap, or in a gunny sack, which can be slipped over the head and body while the animal is still in the trap. Considerable time and patience are required to prevent frightening or exciting trapped beavers, and all movements should be slow and quiet. Care must be taken at first not to give the animals a chance to use their teeth, but as soon as they get over being frightened they are easily handled.

CORRAL TRAPS

Both old and young beavers may be caught in corral traps at the edge of the water. A circular corral may be made of woven-wire mesh, not lighter than No. 16 wire, at least 8 feet in diameter and 5 feet high, with a 3-foot door on the pond side. About seven posts or strong stakes will support the wire, which should be buried a few inches below the surface of the ground and at the top be bent in a 5-inch overhang on the inside. The door posts should be double if a drop door instead of a swinging door is used. Several kinds of swing doors can be devised, but the drop door is perhaps the simplest. It should be raised $2\frac{1}{2}$ feet and hung from the top by a light, easily sprung trigger, with a string attached to a piece of green aspen for bait in the back of the corral or with a long thread to be pulled from a distance when the beavers are seen to be inside. (Fig. 6.)

The beavers can be baited first in the water in front of the corral, then closer, and soon inside. When the whole family or colony have formed the habit of coming into the corral, the door can be set and made ready for their capture. In most places green aspen bushes or branches make the best bait and will soon bring the beavers regularly for their meals. If these are not available the favorite local food can be used and will be preferred by the beavers to that which is to be had by merely going back from the shore and cutting.

Large permanent corrals should be built near the shores where the animals can be fed regularly until they are to be captured for

handling, marking, or selecting on the beaver farm. The corrals should contain large boxes, pits, or dark retreats, where the beavers can hide away from the light and be conveniently examined without being alarmed.

PITFALLS

Adult beavers may be caught in pitfalls sunk across the regular trails where they drag their wood to the water. A hole 14 inches wide by 2 feet long should be dug across the trail 6 or 7 feet deep and the excavation enlarged below to a diameter of 3 or 4 feet. If a barrel or tin can is available it might be sunk into the ground in the trail for holding the beaver. If the pit is in sandy or mellow ground the bottom and the sides up 2 or 3 feet must be protected with boards or tin to keep the animal from digging into the walls and filling up the pit in order to climb out. The excavated earth from the pit should be carried away in pails or sacks, and the surface of the ground left in as natural and undisturbed a condition as possible. When all is completed, the tops of bushes should be laid in from both sides

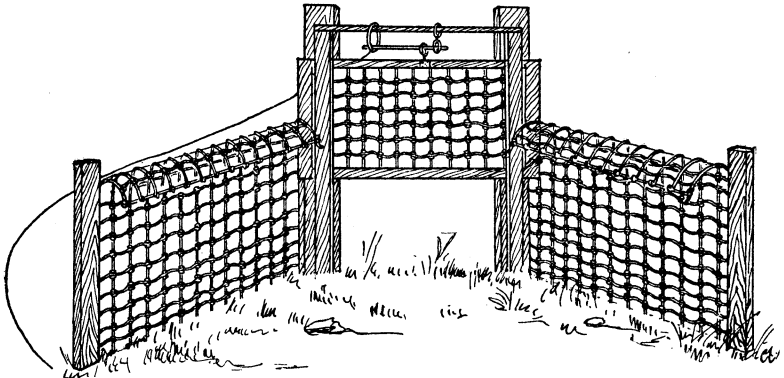


FIG. 6.—Section of corral for capturing beavers alive. Either drop, swing, or sliding doors can be arranged for closing the corral, but the drop door is the simplest where the beavers are to close it themselves from within. Three wire loops and a straight stick for a trigger afford a simple and effective means of springing the door.

of the trail to near the middle of the mouth of the pit and the remainder covered with slender sticks, over which leaves and grass are scattered so that the hole does not show. The beavers may tumble in on the way to their feeding grounds, but are more likely to do so on the return trip, when occupied with carrying or dragging sticks to the water. Once caught in the pit they are easily dipped up in a wire basket or inclosed in a large sack slipped over their heads and bodies.

BEAVER PENS

When captured, beavers can be kept temporarily in pens, buildings, or in large pits or covered dugouts. A room in a house, barn, or shed where they can not escape and will not be frightened or disturbed is most satisfactory. They should have plenty of hay or green bushes on the floor, a large tub or trough of water, and a dark corner or box in which to keep out of the daylight. They are least timid and can be best handled and tamed in a dark or dimly lighted room.

Woven-wire fencing with graduated mesh, 1 inch at the bottom and 4 inches at the top, will make safe pens if 5 feet high, with 10 inches of upper edge left loose at the top on inner side, and the bottom wire securely staked down or run just below the surface of the ground. In one corner a dark pen or beaver house must be provided where the animals can spend the day, and a large tub or trough of water can be sunk into the ground. Sometimes beavers will skin their noses or hurt their mouths on the wires, in efforts to escape, so the wire pen is not so satisfactory as the room or building with walls.

ARTIFICIAL BEAVER HOUSES

Artificial houses should be provided where a new colony is started. A plank or log house 4 feet square with a hole in the bottom and a door in the back or top may be set over the edge of the pond with the bottom just touching the surface of the water, so that the beavers can come up inside. A trapdoor opened and closed with an iron rod or wire from the outside can be fitted over the water hole, so that the beavers can be shut in and examined at any time. If kept in this house over night or a day before being released they will usually come back to it and use it regularly.

Houses built for beavers moved to new localities are generally accepted and occupied permanently or until more suitable houses can be built. In April, 1925, a colony of three beavers was placed in a small pond near the head of Young Womans Creek in southeastern Potter County, Pa., where no beavers had lived for a century or more. Some old rotten logs were piled up on the bank to give them temporary shelter and a dark retreat, and they were left to their own devices. Just a year later a large, well-built beaver house occupied the spot, and a new beaver dam had raised the water about 2 feet to give a satisfactory depth to the pond; food was abundant; and the colony had increased by at least one family and was in a thriving condition. Apparently none had left the colony, although they were free to travel upstream or down.

The beavers placed in a fenced inclosure near Luther, Mich., in September, 1923, were given a box about 2½ feet square with a round hole in the bottom at water level, a dry nest, and a cover. It was occupied by the three beavers the first fall and at least part of the winter, or until a small stick house was built on the shore, and bank burrows were dug into the sidehill. The box was abandoned when the beaver dam raised the water level halfway up its sides.

In central Pennsylvania, in May, 1926, an artificial beaver house was built of boards, placed with the floor flush with the surface of a small pond, and covered with hay and green branches to keep it dark and cool inside. (Pl. 11, A.)

Floating beaver houses on log rafts anchored in shallow water have not been tried, but the possibility of using them is suggested for holding beavers near a good food supply where the shores are too rocky or sandy for their regular houses.

FENCING BEAVER FARMS

After the location has been selected, an inclosure must be prepared that will hold the beavers and protect them from outside enemies. The statements regarding fencing given under the heading Beaver

Control (p. 13), will apply equally well to fencing for beaver culture. In some localities only short sections of beaver-proof fencing will be required, but in others an inclosure strong enough to exclude poachers and dogs will probably be necessary. The more valuable the animals become the more difficult it will be to prevent losses from theft. Care and watchfulness will always be required, and the practice of turning beavers loose to multiply without further effort or attention to their protection on the part of owner will generally prove disappointing.

TYPES OF FENCE

Ordinary 1-inch-mesh poultry netting will hold young beavers, but old beavers will cut it with their teeth and go through. The small young will climb up 2 or 3 feet on the inside of the wire and fall back, and on one occasion a young one was known to climb to the top of a vertical 4-foot fence and tumble down outside.

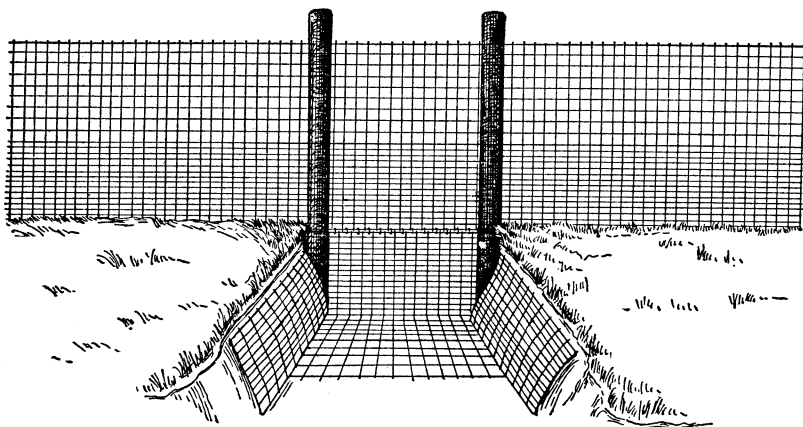


FIG. 7.—Method of fencing across creek. A beaver fence across a small stream should extend 20 or 30 rods beyond the water on each side and be securely laid on the bottom and along the sides of the banks of the stream. If desired, a passageway or swing door in the bottom of the fence under water can be arranged to allow the beavers to pass in but not out of the inclosure.

A fence for holding both young and old beavers that has proved satisfactory in a four-year test is made of galvanized No. 16 woven-wire rectangular mesh, with 4-inch stays, and the spacing graduated from $1\frac{1}{4}$ inches at the bottom to 4 inches at the top. (Fig. 7.) This fence should be 5 feet high with the bottom wire pressing the ground and securely wired to a No. 14 galvanized wire, smooth or barbed, laid $1\frac{1}{2}$ inches underground and stretched tight and stapled to the posts. Such a fence costs in small lots at retail prices 65 to 70 cents a rod. Galvanized-iron posts $7\frac{1}{2}$ feet long are better than wooden posts, as they can not be cut between the wires by the beavers and can be used on either side of the fence. They cost slightly more than ordinary wooden posts, but the time and work saved in setting them offsets the expense, since they are easily driven and the work of digging post holes is avoided. Other advantages of iron posts are that they deter bobcats and raccoons from climbing over the fence and lessen the danger from fire. If wooden posts are

used, they should always be on the outside of the fenced inclosure, where they are less easily cut off by beavers from within, although sometimes they may be slightly gnawed between the wires.

Old beavers will not climb over a fence or dig under it on dry ground unless there is some visible opening beneath. In search of outside food they sometimes scratch at the bottom of the fence but show no inclination to burrow under it. Below the surface of the water, however, beavers will dig under or around a wire fence, unless it is laid on the bottom or extended into the banks of the stream. It is generally necessary to use another width of fencing under water, laid out flat on the bottom and weighted down with stones or fastened with stakes, and to stretch securely staked side wings along the banks for about a rod. If the fence is to prevent the beavers passing either way, the bottom and side wings should be used on both sides of the fence, and if the beavers are to pass in and not out of the inclosure, a V-shaped or funnel-formed opening or swinging door should be placed in the fence near the bottom and entirely under water.

The arms of the fence should stand at right angles to the stream or converge to an apex at the banks, with the ends curved inward toward the stream to serve as an additional check and extending 20 or 30 rods beyond the flood and high-water points. It may be necessary to guard against driftwood clogging the fence in times of flood or high-water and possibly to build a secondary span of fence across the stream channel above for the purpose.

INCLOSURES FOR BOTH BEAVERS AND MUSKRATS

If muskrats also are to be kept within the beaver fence, it will be necessary to add a 10-inch strip of galvanized sheet iron to the inside 12 inches from the ground at the upper edge of the 1¼-inch spacing, securely stapling it to the posts and also fastening it at the top and bottom to the fence wires at not more than 4-foot intervals. This metal strip will add considerably to the expense, but as muskrats are ready climbers, it is probably the simplest way of combining a beaver and muskrat fence. Beavers and muskrats are friendly and often live together in considerable numbers, and as their food is quite different they can be kept to advantage in many localities in the same inclosure.

FEEDING BEAVERS

RAISING YOUNG BEAVERS BY HAND

Raising young beavers by hand and on the bottle can not be recommended at any time before they are ready to be weaned or less than 6 weeks of age. If attempted, it should be only in cases of necessity. Past experiments along this line may, however, be useful to others. Two young beavers, taken from their mother in northern Minnesota when they weighed 24 and 28 ounces, respectively, and were probably 2 or 3 weeks old, were successfully raised by hand, but only with great care and attention. For about three weeks they would take only milk, and although they eagerly accepted it from regular nursing bottles with rubber nipples (pl. 12), fresh cow's

milk did not agree with them. Probably they drank it too fast and possibly took too much at a time. For month-old young, an ounce of whole cow's milk every 4 hours of the 24, kept each satisfied at first, but later the quantity had to be increased to 3 ounces at each feeding. This soon gave them diarrhea, which later was in part avoided by skimming and boiling the milk and by using evaporated or powdered milk. The young beavers soon began to eat green leaves, twigs, tender roots, and clover, and when about 8 weeks of age gave up milk entirely. Thereafter there was no more trouble with their food; they ate green food and rolled oats heartily and grew rapidly.

These two young beavers soon learned what was good and what was not. They were fond of rolled oats, bread, muffins, and crackers. Green leaves, twigs, and bark of fresh aspen, or cottonwoods, birch, bush maple, striped maple, hazel, willow, raspberry twigs, rootlets, stems, and flowers of water lily, tender bases of cat-tails and tules, some sedges, tender grasses, and clovers were eaten. Flower heads of red clover were especially relished.

In the early fur-trade days young beavers were occasionally nursed by the Indian women and raised as household pets, but whether with greater success than on cow's milk has not been recorded. This would suggest the possibility of using sheep, goats, dogs, or other domestic animals as foster mothers when young beavers are to be raised by hand.

There is no trouble in raising young beavers after the nursing period is over, when they are 6 weeks or 2 months old and weigh 3 or 4 pounds each. They become affectionate pets and are little trouble if given a safe inclosure, a pool of water, plenty of food, and a good warm house to sleep in. As they grow older they eat more bark, and in winter their main food consists of bark, leaves, and twigs from the wood cached under water. They also find some roots and green vegetation along the shores and on the bottoms in winter. Both young and old beavers are fond of bread, rolled oats, and cracked corn, and possibly other grains also. The effect of a variety of foods on the size and vigor of animals and on the color and quality of fur is a problem for future study.

FOOD WASTE

In all the beaver colonies under control and observation, as well as in many places in the wild, a great waste of their best food has been observed. Poplars generally grow in close stands, and when cut many lodge against others instead of falling to the ground, where they could be cut into sections and made use of by the beavers. (Pl. 4, A.) This waste often includes more than half the timber cut, and thus needlessly exhausts the readily available food supply. Beavers make a great effort to get the trees down but often without avail. On Mount Desert Island, Me., in dense forest near a creek, was found a tooth-leaved poplar about 6 inches in diameter that when cut off at the bottom could not fall over, and merely dropped with the butt straight down to the ground; six 1-foot sections of the trunk had been cut off and were lying near the stump, and the tree, finally abandoned by the beaver, was dead and still standing erect when seen in July, 1925.

This waste of much of their best food hastens the time when the beavers must seek new shores for their supply of winter provisions, and is a vital factor in their abundance and distribution. Many of the best lakes and streams are abandoned when all the poplars within reach of the water are gone. Beavers prefer to go only about 10 rods from shore for food, but in case of necessity they will sometimes gather their wood as far back as 20 or 30 rods, always going farther uphill than on level ground, as they can return more easily and quickly to the water down a steep slope.

If a man would go through the fall cuttings once a week on beaver farms and cut off and pull down all lodged trees so that they could be utilized by the beavers, a great saving of timber would result, and the period would be prolonged in which the animals could procure their own food supply.

FOOD REQUIREMENTS

In the wild state a large number of beavers can be kept on suitable grounds for an indefinite period if poplar trees beyond their reach are cut and hauled in to the shore for them, a few trees occasionally all summer and in October enough for the winter's supply.

It has also been found that if beavers are cutting hardwood or coniferous trees in places where these have some value, a supply of poplars (any species of the genus *Populus*) hauled in at suitable feeding places will hold the animals in that vicinity and prevent most of the damage to other trees. This has been tried with complete success in several instances. The question arises, however, as to how much timber a beaver requires for a given time, and the answer is still somewhat indefinite. In the Adirondacks, in 1922, 9 beavers were fed for 10 days in September when they were beginning to store for winter. Each day a poplar tree weighing about 100 pounds was carried to the shore of their pond, and from this they ate all they would and stored some of the larger pieces under water near their house. At this season other green food was eaten also, so that the aspen bark was not the only source of food for the colony.

In northern Michigan in October, 1923, stumps were counted where a family of beavers were cutting and storing aspens for the winter, and about 100 small trees, averaging about 2½ inches in diameter and weighing probably 100 pounds each, were found cut and stored near a house on the edge of the lake. The store was practically completed for the season by the end of October and consisted of a winter's supply for a family of six beavers, two old and four young of the year. With some alders and willows there may have been 4 tons of food materials. (Pl. 10, A.)

In a good stand of young aspen growth the trees were counted, and on an average about 16 to a square rod, or 2,560 trees to an acre, were found. They averaged about 3 inches in diameter and 30 feet high, and were shown by the annual rings to be about 15 years old. On another almost pure stand of smaller aspens about an inch in diameter and 5 or 6 years old, there were 50 trees to a square rod, or 8,000 to an acre. In feeding captive beavers in pens one small aspen an inch in diameter is generally found ample for one night's food supply for a full-grown adult. The leaves, twigs, and bark are eaten, with only the solid wood remaining. In the wild state much other food is generally eaten and correspondingly less bark required.

One hundred acres of waste land grown up to poplars and other small trees and brush should permanently feed 100 beavers, besides yielding a steady growth of other valuable timber. This would mean that the poplars should be cut from a part of the land and hauled in to the lake, pond, or stream shores, where the beavers could get them. Of course, many types of land have no poplar growth and are not suitable for beaver culture.

TRANSPORTING BEAVERS

Beavers are easily handled, and surplus stock in one locality may be shipped for long distances if properly crated. Adults will at first rarely eat anything if kept in close confinement and when captured should be shipped at once to their destination or else kept in an inclosure large enough to have a house and a swimming pond well supplied with food.

For two adult beavers a box 3 by 4 feet and 1½ feet high should be used, with partly open wire-mesh top and hand grips at the ends. One end or corner should be covered or inclosed for a dark retreat and nest. For food, bundles of aspen branches, or cottonwood, hazel, bush maple, or willow should be nailed to the sides and some branches, twigs, and leaves laid on the floor. For a three or four days' journey, two loaves of white bread should be fastened into the corners and a box containing 2 pounds of rolled oats nailed to the side or bottom of the box; a 2-quart tin pail to hold water should be fastened in one corner, so that it can be filled from the top; no additional food need be supplied, but instructions should be given and written on the label, to keep the pail half full of water. Beavers are thirsty animals and suffer if they do not have plenty of water to drink. They usually show no inclination to gnaw out of the box when there is daylight above and will travel quietly and comfortably, except for fear and nervous excitement, which should so far as possible be avoided. The box should be marked RUSH, and no delays allowed. At their destination the beavers should be placed at once in a pond or other swimming water and given a dark nest place. With this treatment their fear and nervousness will soon be removed, and they will eat and function normally.

Under normal conditions beavers never deposit their feces except in the water, where they sink to the bottom or dissolve and disintegrate. There is never a trace of them in the houses, not even in those occupied by young, nor on the banks or shores. In captivity beavers often hold their pellets as long as possible if no water is at hand, and unload them as soon as they get into water again. For this reason they should always, if possible, have access to clean or running water.

MARKING FOR NUMBER, SEX, AND AGE

It is difficult to determine the sex of beavers as their genital organs are internal. The male has a straight bone 1 inch to 1½ inches long in the penis, lying between the two large musk glands under the skin just in front of the anus. The female may be recognized by the absence of this character and by the two conspicuous teats on each of two mammary glands. The shape of tail and other external characters seem to have no relation to sex.

Every beaver should be carefully examined and in some conspicuous way marked for both sex and age. Branding on top of the tail with either a hot iron or chemicals would be permanent and conspicuous. Either serial numbers or a sex mark and the year of birth might be used. Large numbers in white or aluminum paint on top of the tail would be most convenient if they could be made permanent, but in the experiments so far carried out the paints have not lasted.

At the suggestion of an expert chemist, a paint made of pure oxide of zinc worked into a commercial household cement was applied to the top of the beaver's tail when dry and clean. In eight cases a number, sex mark, and "26" for the year were painted in conspicuous characters large enough to be read 50 feet away. One beaver, turned out in the lake after one night in a close pen where constant moving about and turning and scraping the surface of the tail against the sides or floor wore off much of the paint, showed only faint traces of the marking when caught in the live trap a week later.

Aluminum bands around the base of the tail could be used for full-grown beavers but would not do for the young or immature on account of the steady growth of the tail. The same would apply to leg or wrist bands, as there is little constriction above either heel or hand. The ears are too small and concealed for tags or other marks, except a small notch in the tip, which can be seen only on close examination with the beaver in the hands.

Tail marks seem to offer the only practical solution of the problem, and the next experiments will be with an aluminum button bearing a number and clamped through the thin part of the tail an inch from the edge, where the fatty tissues and tough cuticle are least sensitive. A tag with a flat head below, such as is used for pants buttons, will close down and press on the surface and be less likely to be torn off than a loose tag at the edge of the tail.

DISPOSING OF THE PRODUCTS

RATE OF INCREASE

The natural rate of increase in a beaver family or colony should be, under favorable conditions, a doubling of the stock each year. With the older females, four to six young, about evenly divided between males and females, is the usual number to the litter, and there is usually but one litter a year. Some of the young females have one or two young when a year old, and others do not breed until two years old. If the number of males be reduced by disposing of half the older ones for fur or breeding stock, the retained stock should somewhat more than double each year. Beavers are polygamous, and one male to two females should be a better arrangement than equal numbers of the sexes. This, however, has not been fully tested, and a smaller number of males may be still better.

With a stock of 100 or 1,000 beavers one year, the same number could be disposed of for breeding stock the following and each succeeding year by selling them in families of old male and female and young together, as a family makes the best beginning for a new colony. In selling for fur, however, only beavers 2 or 3 years old

should be marketed, and this makes it necessary to carry a larger number than can be disposed of the following year for pelts.

KILLING BEAVERS FOR THEIR FUR

The trapper's method of killing animals by a quick blow on top of the head, if properly and skillfully done, is probably better than any other one known. The blow should be made across the top of the head, back of the eyes, with a heavy round hardwood stick, or a 2-foot section of a 1-inch iron pipe, and with sufficient force to break the rather heavy skull and instantly stun and paralyze the animal. When the skulls or skeletons are to be saved for natural-history specimens, the animals may be placed in a tight, covered box or metal can of as small size as will take them in comfortably, and 1 ounce of carbon disulphide poured into the can and allowed to evaporate. The gas soon anesthetizes the animals, and if they are left for an hour they will not revive. Other gases, including ether, benzine, and gasoline also are effective, but those that are explosive or poisonous must be used with great care.

TAKING AND PREPARING SKINS

Beaver skins should be taken only in midwinter, when the fur is prime, unless there should be a special demand for unplucked beaver fur, which is at its best before the outer guard hairs are full grown, while short and glossy in September or October. It is then much like unplucked otter fur, and especially suitable for men's coats or collars.

The skins are usually taken off by a cut along the median line of the belly and stretched in circular form on a board or hoop. They must be removed carefully with a sharp knife, as they do not peel off, but have to be cut close to the skin all the way. The skins should be stretched and dried in a cool dry place and kept cool until marketed, so that the oil will not soften and injure the hide.

UTILIZING THE MEAT

A beaver skinned and dressed will weigh a little more than half as much as before; that is, a fair-sized animal will dress 25 to 30 pounds. This should include the tail and liver, which are especial delicacies. The tail is fatty tissue, rich and palatable when cooked, and was greatly relished by early trappers and explorers. The liver is large and almost as tender and sweet as that of a chicken or goose. The body meat has rather a gamy flavor, but if properly cared for and cooked is excellent and was generally preferred by trappers to any other game, even in the early days when buffalo, elk, and deer were abundant.

Great care must be taken in skinning a beaver not to get a trace of the musk on the meat, or it will be ruined. The musk and oil glands should be left on the skin until after it is removed, and especial care must be taken not to get any musk on the knife or hands. The musk glands have a small commercial value and are usually saved and dried. The carcass should be hung up by the head and kept clean. It might be possible to develop a market for beaver meat if properly handled.

CONCLUSIONS

IMPORTANCE OF BEAVERS

Beavers are of primary importance as fur bearers and conservators of water and soil; because of their unique habits they are also animals of general interest. In certain types of forest country, on farms, in irrigation ditches, and along trails, roads, and railroads they are capable of doing serious damage; in such situations it becomes necessary either to remove or to control them. Their control, however, is not difficult, and where they are doing damage on private lands they can be quickly removed either by trapping alive for shipment or killed for their fur.

ATTITUDE TOWARD BEAVERS

If beavers are to be treated as public property, it is as objectionable to place them on private land where they will destroy crops and timber as it would be to turn herds of hogs and cattle into cultivated grainfields to fatten on what they like best. A thorough knowledge of their nature and habits is necessary for their control, as it is also for their successful culture. In many States the game laws provide for a license, allowing the capture and raising of fur-bearing animals under necessary restrictions as a private industry. In States having no such provision the legislatures might well authorize the game commissions to provide licenses and to take such other means as are necessary to encourage, regulate, and control the beaver industry and, where necessary, to protect private property.

BEAVER FARMING

The practicability of beaver farming has not been fully demonstrated, but, according to present knowledge, it seems reasonable to believe that the business will develop into a profitable branch of fur farming. Many problems must still be worked out, such as family and sex relations, extent of sociability and enmity, effects of large numbers on the health and increase of the stock, possible diseases, protection from natural enemies and poachers, and actual values and profits. The more immediate problems of capture, feeding, breeding, fencing, control, and shipping, however, have been mainly solved. To start beaver farming on a large scale at present might be unwise, but with a small beginning the enterprise seems to promise good returns and even great possibilities. When fully established it should increase the value of a large area of north country and, by insuring a permanent supply of excellent fur, open up a new industry where much needed. Only such areas as are determined to be suitable should be stocked with beavers; the animals should not be introduced uncontrolled into places where their activities may menace irrigation or power ditches or important road or railroad grades. Sites selected for beavers should contain a suitable food supply and permanent water.

UTILIZING FOREST AREAS

Over a large part of the millions of forested acres beavers are capable of doing far more good than harm in conserving water and

soil, weeding out timber of little value, yielding substantial returns in an annual fur harvest, and making the silent places teem with interest. By intelligent control, which would avoid local damage to valuable timber and other property, and by wise restraint, which would prevent the dispersal of beavers over surrounding country, most of the damage occasioned by beavers can be eliminated. On some of the national forests beavers are already present and in places are increasing in numbers, but most of the animals are of the western, pale, native varieties, worth much less than the choice, dark, high-grade fur bearers that might be introduced from other sections. Improving the system of stocking, management, and control will make beavers valuable inhabitants of the forest.

USE OF CLEARED TIMBERLANDS

Another fertile field for beaver culture could be found in connection with projects for the reforestation with conifers of burned, cut-over, and cleared timberlands. Many of these areas, cleared by ax or fire, and later covered with a second growth of aspen, willow, and pin cherry, are considered almost worthless. Over much of the northern part of the United States and still larger areas in Canada, such land is generally unsuited for agriculture and would not pay taxes until again covered with valuable forest timber. It would, however, supply ideal food for beavers, and if stocked with these animals could be made to yield an income while the process of reforestation is going on. Not only could many limited areas of private land be thus reclaimed, instead of, as is so often the case, being relinquished as not worth their taxes, but State and Federal lands of this type could also be utilized for the double industry of fur and forest production.

NORTHERN WASTE LANDS

There is a still more extensive field for beaver culture in the more northern areas of Canada and Alaska, in regions that are beyond the commercially valuable forest timber but where aspens and willows are an abundant part of the natural forest growth and where beavers were once so numerous as to yield annually thousands of dollars worth of fur. If instead of the old policy of encouraging the extermination of animals by a wild scramble to get their skins, definite areas in these parts were leased or sold to individuals or companies for raising beavers under control, as private property, this once valuable fur region would again become productive and develop related industries.

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